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FLOOD INSURANCE STUDY

CITY OF LIVERMORE, CALIFORNIA
ALAMEDA COUNTY

REVISED: JULY 3, 1990

Federal Emergency Management Agency

COMMUNITY NUMBER - 060008

AG—

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all the data available within the repository. It is advisable to contact the community repository for any additional data.

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

1.1 Purpose of Study 1
1.2 Authority and Acknowledgments 1
1.3 Coordination 2

2.0 AREA STUDIED 2

2.1 Scope of Study 2
2.2 Community Description 4
2.3 Principal Flood Problems 5
2.4 Flood Protection Measures 6

3.0 ENGINEERING METHODS 7

3.1 Hydrologic Analyses 7
3.2 Hydraulic Analyses 18

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS 19

4.1 Floodplain Boundaries 19
4.2 Floodways 20

5.0 INSURANCE APPLICATION 21

6.0 FLOOD INSURANCE RATE MAP 29

7.0 OTHER STUDIES 29

8.0 LOCATION OF DATA 30

9.0 BIBLIOGRAPHY AND REFERENCES 30

TABLE OF CONTENTS (cont'd)

Page

FIGURES

Figure 1 - Vicinity Map 3
Figure 2 - Frequency-Discharge, Drainage Area Curves 10
Figure 3 - Floodway Schematic 21

TABLES

Table 1 - Floodway Data 22

EXHIBITS

Exhibit 1 - Flood Profiles

Arroyo Mocho	Panels 01P-06P
Arroyo Las Positas	Panels 07P-14P
Altamont Creek	Panels 15P-17P
Arroyo Seco	Panels 18P-20P
Arroyo Las Positas Relocation	Panels 21P-22P
Arroyo Del Valle	Panels 23P-24P
Cayetano Creek	Panels 25P-26P
Collier Creek	Panel 27P

Exhibit 2 - Flood Insurance Rate Map Index
Flood Insurance Rate Map

Exhibit 3 - Elevation Reference Marks

FLOOD INSURANCE STUDY
CITY OF LIVERMORE, ALAMEDA COUNTY, CALIFORNIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Livermore, Alameda County, California, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

This Flood Insurance Study revises and updates a previous Flood Insurance Study/Flood Insurance Rate Map for the City of Livermore, California, dated January 1977 (Reference 1). This information will be used by the City of Livermore, California, to update existing floodplain regulations as part of the Regular Phase of the NFIP. The information will also be used by local and regional planners to further promote sound land use and floodplain development.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the initial study were performed by the U.S. Army Corps of Engineers (COE), San Francisco District, for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement Nos. IAA-H-19-74 and IAA-H-16-75 and Project Order Nos. 17 and 14, respectively. The initial study was completed in March 1976.

The hydrologic and hydraulic analyses for the streams which were added from the Alameda County Flood Insurance Study were performed by Development and Resources Corporation for FEMA, under Contract No. H-3682. The streams added are as follows: A portion of Arroyo Mocho, a portion of Arroyo Las Positas, a portion of Altamont Creek, a portion of Arroyo Seco, a portion of Arroyo Las Positas Relocation, Arroyo Del Valle, Cayetano Creek, and Collier Creek. The study was completed in March 1976.

1.3 Coordination

Efforts to obtain information for the initial study were coordinated through the Department of Public Works, the Planning Department, and the Livermore Area Recreation and Parks District.

Contacts with the Alameda County Flood Control and Water Conservation District provided construction plans for existing flood control facilities, topographic maps, county plans, and some hydrologic data.

One coordination meeting was held with Grunwald, Crawford and Associates, a consultant now preparing a new master plan for the city.

The final coordination meeting for the initial study was held on February 9, 1976. The study was presented to the city's Director of Planning and other city officials. District representatives answered technical questions.

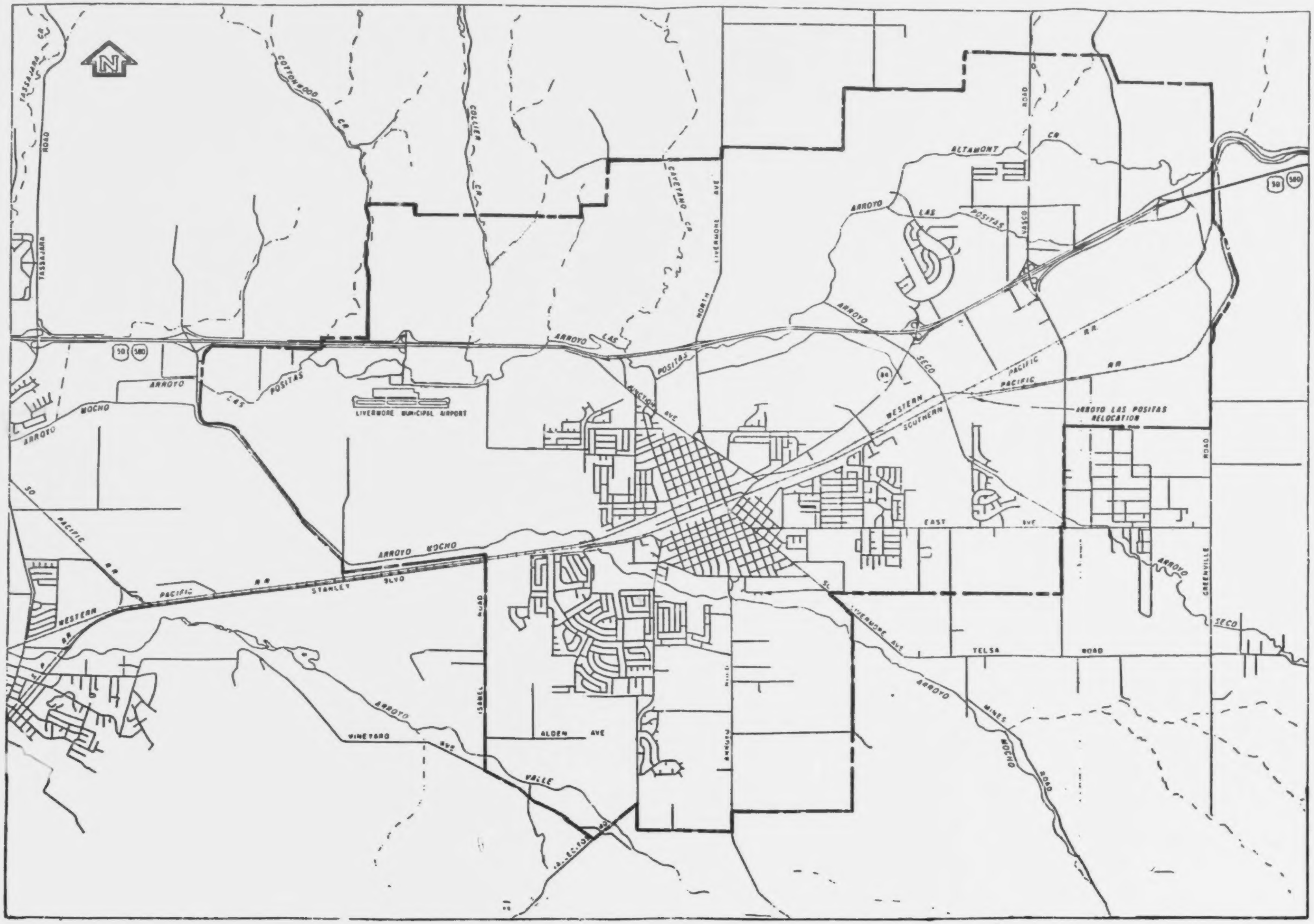
2.0 AREA STUDIED

2.1 Scope of Study

The City of Livermore, located in Alameda County, California, is the area covered by this Flood Insurance Study. The study area includes the incorporated areas of Livermore and streams outside of the city that cause flooding within the city. The study area is shown on the Vicinity Map (Figure 1).

The City of Livermore is located in the Livermore Valley, which lies in the Alameda Creek basin. The area is drained by Arroyo de la Laguna and its tributaries. Streams studied in detail include Arroyo Mocho, from the city limits downstream to Wente Street; Arroyo Las Positas, within the city from its confluence with Altamont Creek downstream to El Charro Road; Altamont Creek, from its confluence with Arroyo Las Positas upstream to the corporate limits; Arroyo Seco, from its confluence with Arroyo Las Positas upstream to South Vasco Road; Arroyo Las Positas Relocation, from its confluence with Arroyo Seco upstream to the corporate limits; Arroyo Del Valle, from Holmes Street downstream to Isabel Avenue; Cayetano Creek, from its confluence with Arroyo Las Positas upstream to the corporate limits; Collier Creek, from its confluence with Arroyo Las Positas upstream to the corporate limits.

The initial studies considered historical flooding and existing floodplain modifications that would significantly change the historical flood hazard.


N
TASSAJARA CR.
TASSAJARA ROAD
COTTONWOOD CR.
COLLIER CR.
CAYETANO CR.
NORTH LIVERMORE AVE
ALTAMONT CR.
VASCO ROAD
ARROYO LAS POSITAS
50
580
ARROYO MOCHO
LIVERMORE MUNICIPAL AIRPORT
ARROYO LAS POSITAS
84
ARROYO SECO
WESTERN PACIFIC R.R.
SOUTHERN PACIFIC R.R.
ARROYO LAS POSITAS RELOCATION
EAST AVE
GREENVILLE ROAD
ARROYO SECO
SO. PACIFIC R.R.
WESTERN R.R.
ARROYO MOCHO
STANLEY BLVD
ISABEL ROAD
ARROYO VALLE
VINEYARD AVE
ALDEN AVE
LIVERMORE AVE
TESLA ROAD
ARROYO MOCHO
MINES ROAD

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)

VICINITY MAP

APPROXIMATE SCALE

0 4000 8000 12000 16000 FEET

FIGURE 1

3

This study revises Arroyo Las Positas from its confluence with Arroyo Seco up to its confluence with Altamont Creek and revises Altamont Creek from its confluence with Arroyo Seco to North Vasco Road.

The hydraulic analyses for the above revised streams were performed by Lindberg Technical Services and were completed in September 1987.

This study also revises corporate limit boundaries to reflect an annexation to the City of Livermore. Because of this annexation, several streams were added to this Flood Insurance Study from the Flood Insurance Study for Alameda County, dated February 19, 1986 (Reference 2). These streams are as follows: A portion of Arroyo Mocho, a portion of Arroyo Las Positas, a portion of Altamont Creek, a portion of Arroyo Seco, a portion of Arroyo Las Positas Relocation, Arroyo Del Valle, Cayetano Creek, and Collier Creek.

2.2 Community Description

The City of Livermore is located 35 miles southeast of the City of San Francisco and 3 miles east of the City of Pleasanton.

The floor of the Livermore Valley slopes gradually from east to west, with the City of Livermore in its center at an elevation of 480 feet above mean sea level. The Livermore Valley is approximately 12 miles long and ranges from 3 to 8 miles wide from north to south. Rolling hills line the north and east sides of the valley, with steeper mountains bordering the south and west edges. The valley is located in the southern Coast Range Mountains.

The first settlement in Livermore was Rancho Las Positas, a cattle ranch established in 1839 by Robert Livermore and Jose Noriega. More ranchers came to the area to take advantage of the native grasslands for grazing, and much land was converted to cropland for farming. Agriculture remained the chief economic base of the Livermore area for more than a century.

Livermore was incorporated as a town in 1876 and as a city in 1930. Since the 1940s, research in nuclear physics and nuclear weapons has become the principal economic base of the city. Other industries include the manufacture of industrial glass fabrics and the excavation of sand and gravel. Industrial growth has been accompanied by residential and commercial development. Agriculture is still important, however, and the areas surrounding the city are noted for their rose seedlings and white wines. The population of the city grew from 16,100 in 1960 to 37,700 in 1970, and by 1974 was approximately 50,000 (Reference 3). By the year 2000, a population between 73,000 and 82,000 is expected.

The climate in the Livermore Valley is typical of inland central California low-elevation valleys. It is semiarid, with fairly hot, dry summers and cool, damp winters. In the city, the average annual termperature is 59.3°F and average annual rainfall is 14.5 inches (Reference 4). The hills bordering the valley receive higher average annual precipitation.

The Livermore Valley, a part of the Alameda Creek drainage basin, is drained by Arroyo de la Laguna, a major tributary of Alameda Creek southwest of Livermore. Tributaries to Arroyo de la Laguna that drain the City of Livermore and surrounding regions include Arroyo Mocho, Arroyo Las Positas, Arroyo Seco, and Altamont Creek. No major bodies of water exist in the Livermore Valley, although several small lakes lie west of the city.

The floodplains in the City of Livermore have been partially developed, and without controls further encroachment is likely. Land on the Arroyo Mocho and Arroyo Seco floodplains contains open space as well as residential and commercial development. Along the Arroyo Las Positas and Altamont Creek floodplains, the land is primarily open, with some residential development. The floodplain of the Arroyo Las Positas Relocation remains open space. In addition to the above-mentioned development, public utilities, city streets, and railroads constructed upon the floodplains are threatened by flood damage. The City of Livermore has indicated its concern with floodplain development by purchasing a strip of undeveloped floodplain along Arroyo Mocho to be retained as open space.

2.3 Principal Flood Problems

Flood-producing rainfall occurs during the winter months in the Livermore Valley. Storm runoff is concentrated rapidly by the network of tributaries that discharge through the hills into the major streams. The tributaries have carved well-defined courses through the hills; but, upon reaching the flat Livermore Valley, the channels become shallow and inadequate for lower return-frequency flows. Constriction of Arroyo Seco flows at the Western Pacific and Southern Pacific Railroad crossings of the creek forces lower-frequency floodflows to spread out from these points. Another constricting hydraulic factor is a length of channel along Arroyo Las Positas upstream from Airway Boulevard. Rapid runoff rates, inadequate channels, and constricting structures combine with the development of some floodplain areas to make the City of Livermore susceptible to damage when large rainstorms occur.

The largest flood recorded at the City of Livermore occurred in January 1952, doing damage to railroads, bridges, roads, utilities, and the Coast Manufacturing and Supply Company (now the Hexcel Corporation) that was estimated at $100,000 (Reference 5). Damages were caused by floodwaters from Arroyo Seco, which backed up at the Western Pacific Railroad trestle and spread out over the flat land. The following paragraph, from the January 17, 1952, edition of the Tri-Valley Herald describes some of these damages.

> Widespread storm damage in the Livermore area was highlighted early Saturday by $15,000 in losses occasioned to the Coast Manufacturing and Supply Company plant by a flash flood of Las Positas Creek. Waters raced through

9

> the company property with such speed that employees could not stop them from entering the basement of the mill building, where, said President Ralph E. Merritt, considerable quantities of raw materials and finished goods were stored.
>
> In the short space of 30 minutes, sufficient water entered the basement to cause the $15,000 losses.

In 1937, floodwaters damaged parts of U.S. Highway 50 (now Interstate Highway 580 also), which traverses the northern portion of the city. Before better storm drains were installed, water frequently ponded in the streets of the central area of the city.

Along Arroyo Las Positas, the flooding at Airway Boulevard is caused by severe upstream channel constrictions. During the 100-year storm, 20 percent of the flow leaves the channel and crosses over Airway Boulevard, bypassing the bridge structure. Sheet flooding occurs in this area. Downstream from Airway Boulevard, the golf course has been designed for bypass and passage of the 100-year flood.

Potential flooding along Arroyo Las Positas downstream from Bluebell Road is a result of backwater created by undersized channel and culvert structures in the downstream segments located outside the city limits.

Another potential flood problem stems from Arroyo Seco along the southern edge of the Southern Pacific Railroad tracks. A complex division of flows at the Western Pacific and Southern Pacific Railroad crossings of Arroyo Seco directs flow along the tracks and into the City of Livermore.

2.4 Flood Protection Measures

The City of Livermore has purchased an easement for a strip of undeveloped floodplain along Arroyo Mocho in the southwestern part of the city, which will be preserved as open space. The easement will accommodate the 100-year flooding of Arroyo Mocho.

Along Arroyo Las Positas, a swale with primary and secondary channels, four wood bridges, and four double-corrugated metal pipe culverts has been designed to convey floodflows through the Las Positas Golf Course. Upstream, from the Airway Boulevard Bridge to the Kittyhawk Road low-water crossing, a trapezoidal channel has been constructed.

A flood overflow area, through which Las Positas Creek crosses the Springtown Golf Course was enlarged to carry greater flows. Through the Springtown Homes area, the Arroyo Las Positas watercourse has been graded to form a broad trapezoidal earth channel.

Two segments of the Arroyo Seco channel have been altered to contain the 100-year flood. One segment extends from the crossing of the Western Pacific Railroad over Arroyo Seco to the confluence of Arroyo Seco and Arroyo Las Positas, a distance of 1.25 miles. This improved reach includes a leveed trapezoidal channel section with a multiple-box culvert at each of the two highway crossings. The other improved reach of Arroyo Seco covers a length of 0.5 mile from just below Lucille Street to just above Charlotte Way. This reach has a supercritical, concrete-lined, trapezoidal channel with bridge and drop structures.

Altamont Creek has two lengths of constructed channel within Livermore. One is an earthen trapezoidal channel and the other is a concrete trapezoidal channel. Three concrete culverts are associated with these channels.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflected flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

One streamflow gage exists on the streams studied. The U.S. Geological Survey installed one in 1963 on Arroyo Mocho near Pleasanton, 1 mile downstream from the western city limits. A flow-frequency curve was developed for the 11 years of published record using the log-Pearson Type III method as prescribed by the Water

Resources Council (Reference 6). Since 11 years is too brief a period from which to develop an accurate flow-frequency curve, a partial duration series curve was developed. The combination of the two curves gives a good indication of the flow-frequency curve at the gage, with the flows of a recurrence interval of more than 10 percent being better defined than those less frequent. The developed flow-frequency curve is not considered to be representative for flows greater than 1,000 cubic feet per second (cfs).

Flood peaks from the Arroyo Mocho and the Arroyo Las Positas watersheds will be substantially attenuated because of the limited channel capacity of both upstream channels. Both channels have sections a short distance upstream of the gage with flow capacities of less than 500 cfs.

With the lack of gage data, it was decided to use the Arroyo Mocho watershed above the gage as a control basin, and to develop unit hydrographs and loss rates that would serve as the basis for developing parameters for use in each of the study's sub-basins. A second basin, Arroyo Mocho above Isabel Avenue, was also analyzed since the COE, San Francisco District, had previously determined a peak-flow frequency curve at that location.

Unit hydrographs were developed for each of the two watersheds using lag relationships developed by the COE, San Francisco District (Reference 7).

Using the developed unit graph for the gaged basin, the storms of January and November 1970 were reconstituted using the computer program Flood Hydrograph Package, HEC-1 (Reference 8). Judgment was used in selecting the rainfall totals and distributions to be used for the two storms from the rain gage records. The computer program's standard loss rate function was used in the reconstitutions, with the function's individual parameters varied to arrive at the best reproduction of the recorded hydrographs. Valid reconstitutions were achieved for both storms.

The loss rates determined in the reconstitution process were then compared with the COE time-interval-step method for reducing loss rates. The comparison of the loss rates by both methods indicated that the ones determined in the storm reconstitutions were reasonable with respect to COE experience in the area.

Good reproduction of the gaged hydrographs confirmed the selection of the initially developed unit graph and the subsequently determined loss rates.

Hypothetical storm rainfall amounts for the study area for several durations and several rainfall intensities were determined in terms of percent of normal annual precipitation (NAP), using data developed by the California Department of Water Resources (DWR)

(Reference 9). Stations near the study area for which statistical rainfall data had been developed were used to develop rainfall data for the study area. The stations used were Walnut Creek 2ENE, Niles 1SW, Upper San Leandro Filters, Orinda Filters, and Hayward 6ESE. Statistical rainfall amounts were taken from the DWR data for several durations for each rainfall intensity studied and were converted to percent of NAP at each station. The values calculated for each of the five stations were then averaged to establish the rainfall intensity-frequency-duration data used in the study. The following tabulation presents the rainfall amounts, in percent of NAP, that were used for this study.

	Duration (hours)				
Event	1	6	12	24	72
10-Year	4.2	10.5	14.9	21.3	30
100-Year	6.0	15.1	22.2	33.5	47
500-Year	7.2	17.7	26.4	40.4	52

Loss rates were derived for each storm in accordance with COE procedures. The range of losses is as follows:

Storm Frequency	Inches per Hour
10-Year	0.30 to 0.14
50-Year	0.23 to 0.13
100-Year	0.22 to 0.12
Standard Project Flood	0.18 to 0.08
500-Year	0.16 to 0.06

Rainfall and loss rates were tabulated and the excess rainfall was determined. The excess rainfall was then used as input data for the HEC-1 computer program. The unit graph multiplied by the excess then gave the resulting hydrograph.

The 10-year to 500-year flows at the gage on Arroyo Mocho near Pleasanton were then plotted on log-probability paper and a best-fit, straight line was drawn through them. The Standard Project Flood (SPF) value was plotted at the 250-year (0.4-percent) return frequency. The hypothetical flows for the index point at Isabel Avenue were then plotted and a line parallel to the gage flow-frequency line was drawn through the SPF value at 0.4 percent. This straight line was a good fit for the plotted values. It was then concluded that the flow-frequency curve for each sub-basin in the study would be represented by drawing a parallel line to that drawn at the gage near Pleasanton through the sub-basin's SPF value plotted at the return frequency of 0.4 percent.

The SPF was computed for each sub-basin and the values were plotted. The subbasin flow-frequency curves were then drawn and the flows were tabulated.

Drainage area-peak discharge relationships for streams in the City of Livermore are presented in Figures 2-10.

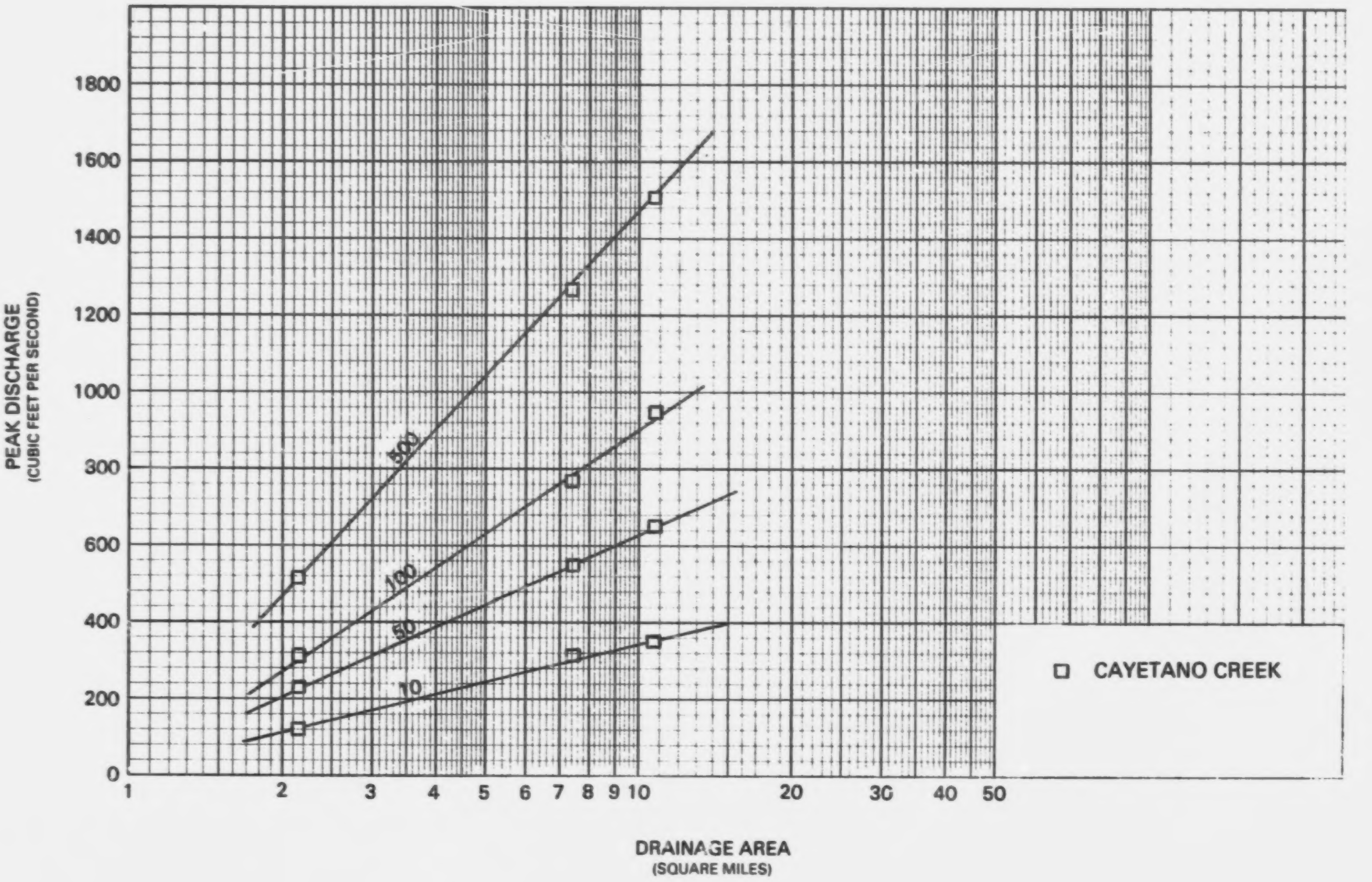


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

CAYETANO CREEK

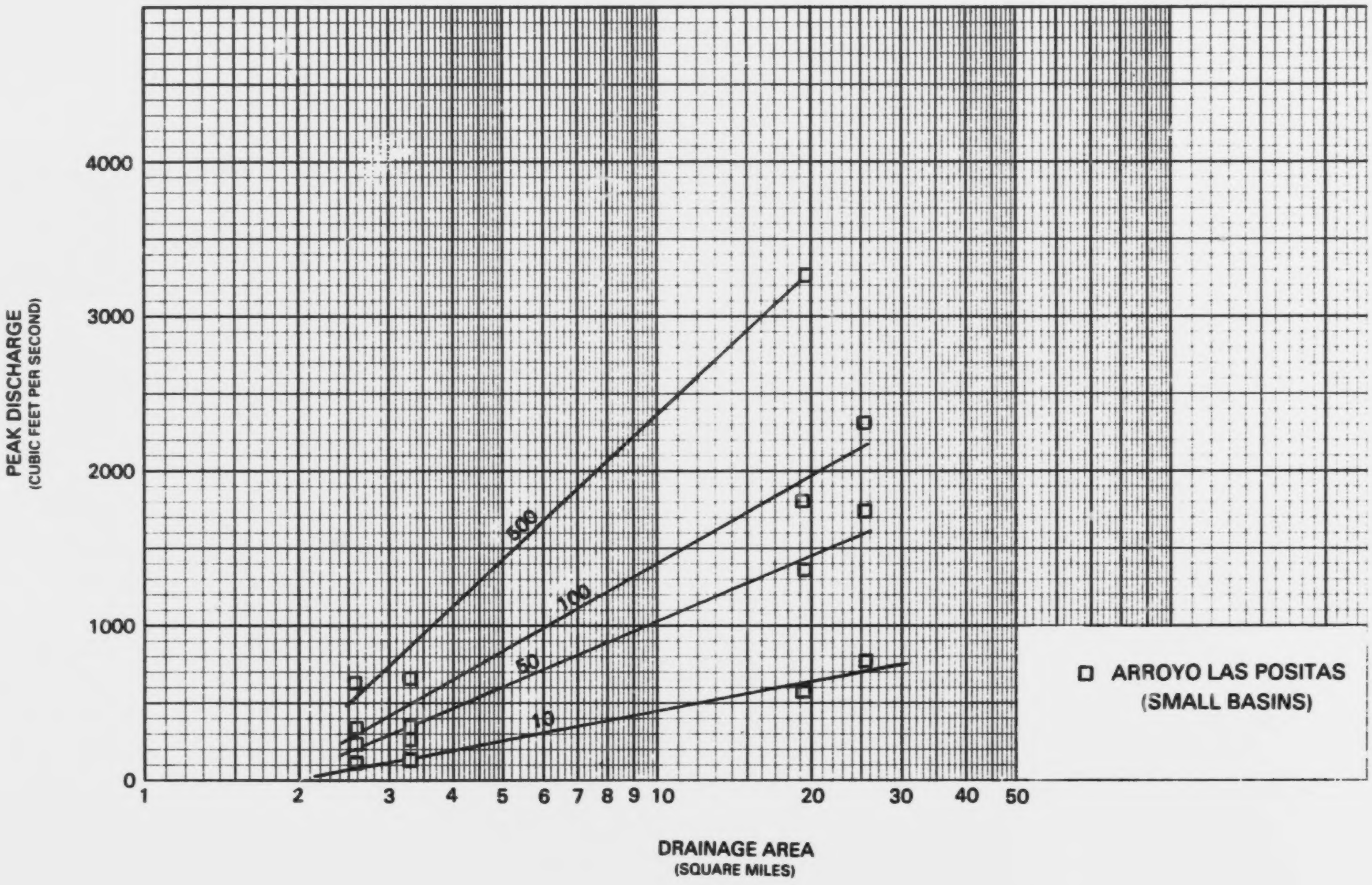


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ARROYO LAS POSITAS

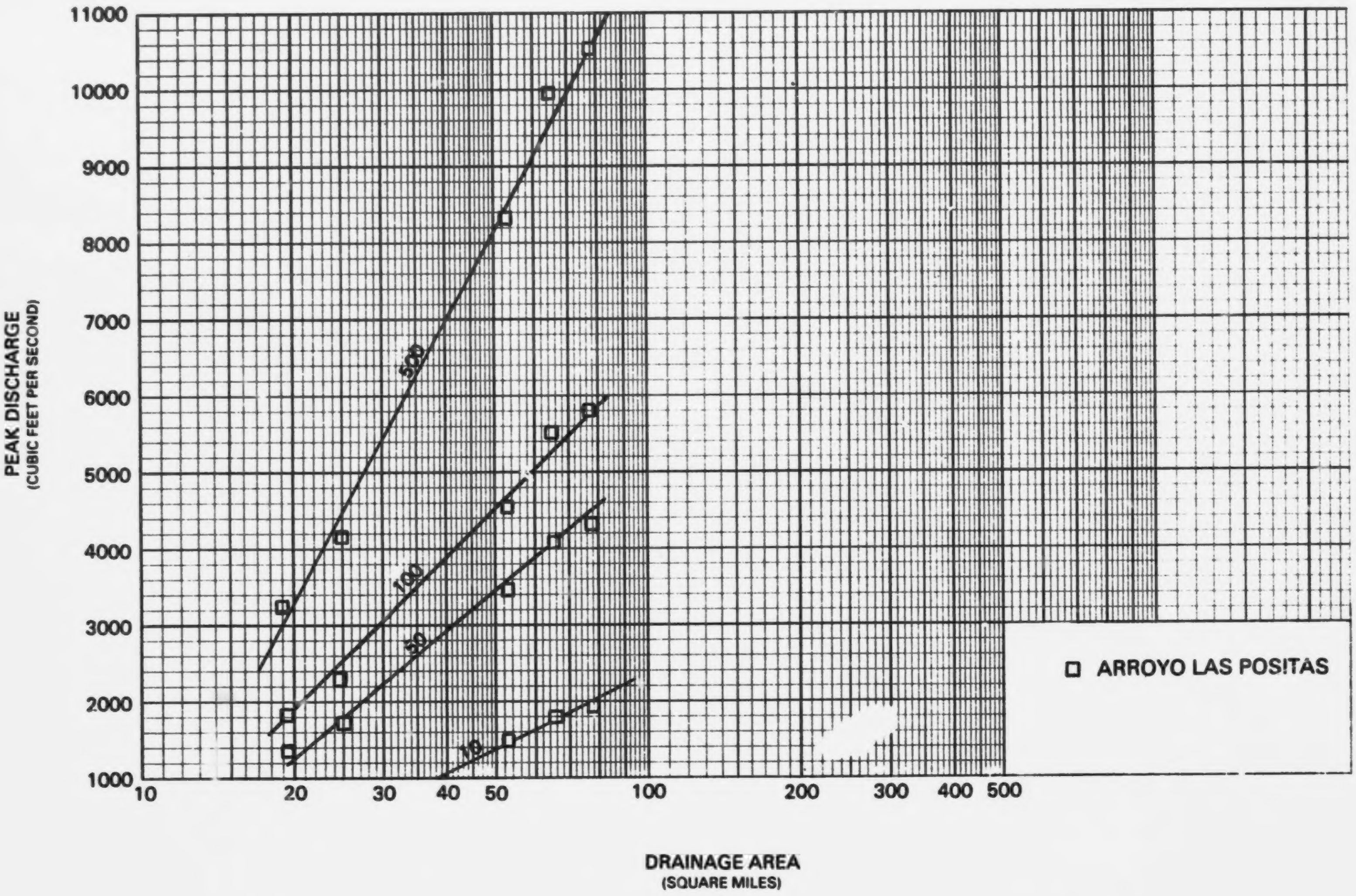


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ARROYO LAS POSITAS

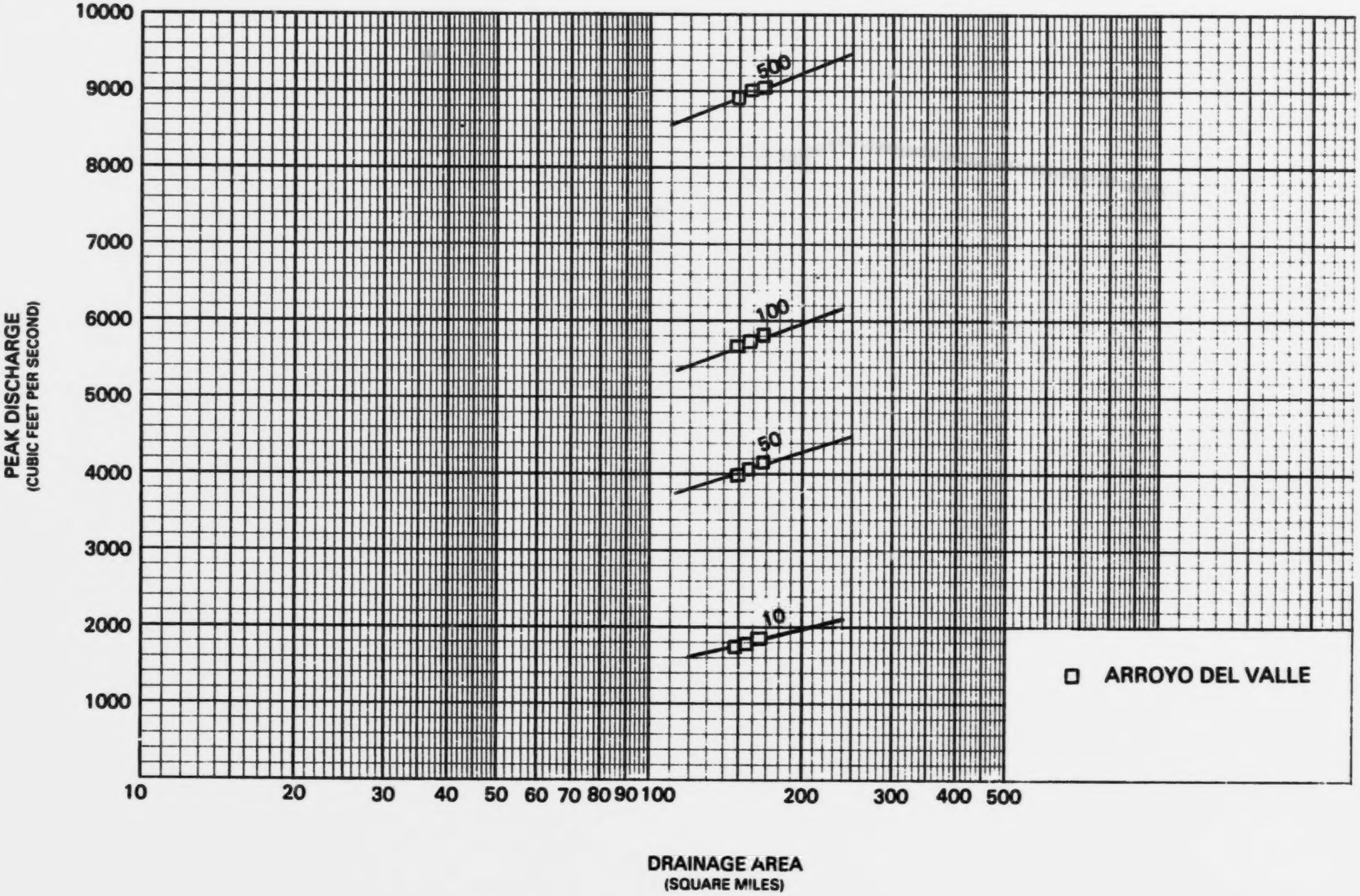


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ARROYO DEL VALLE

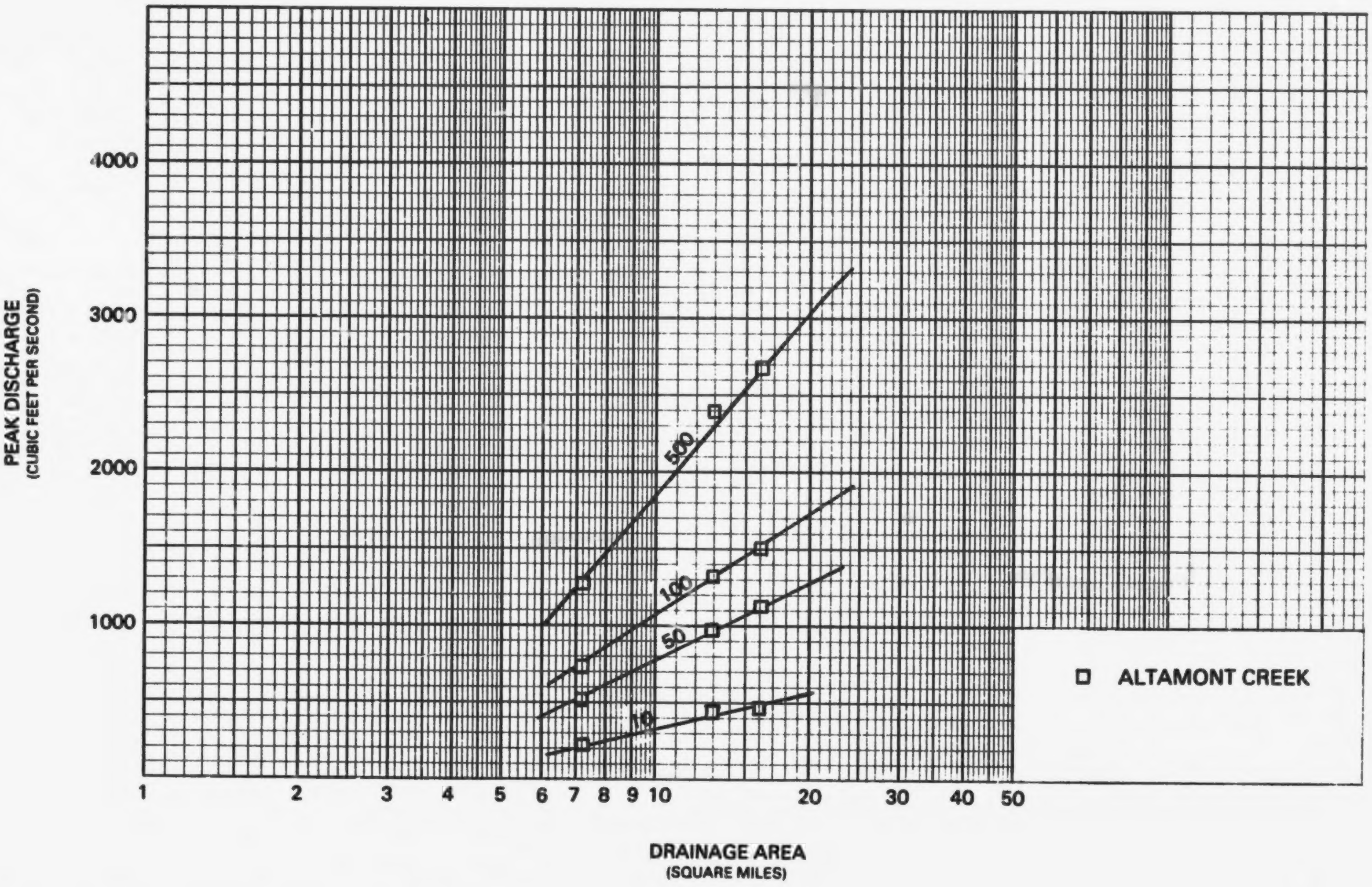


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ALTAMONT CREEK

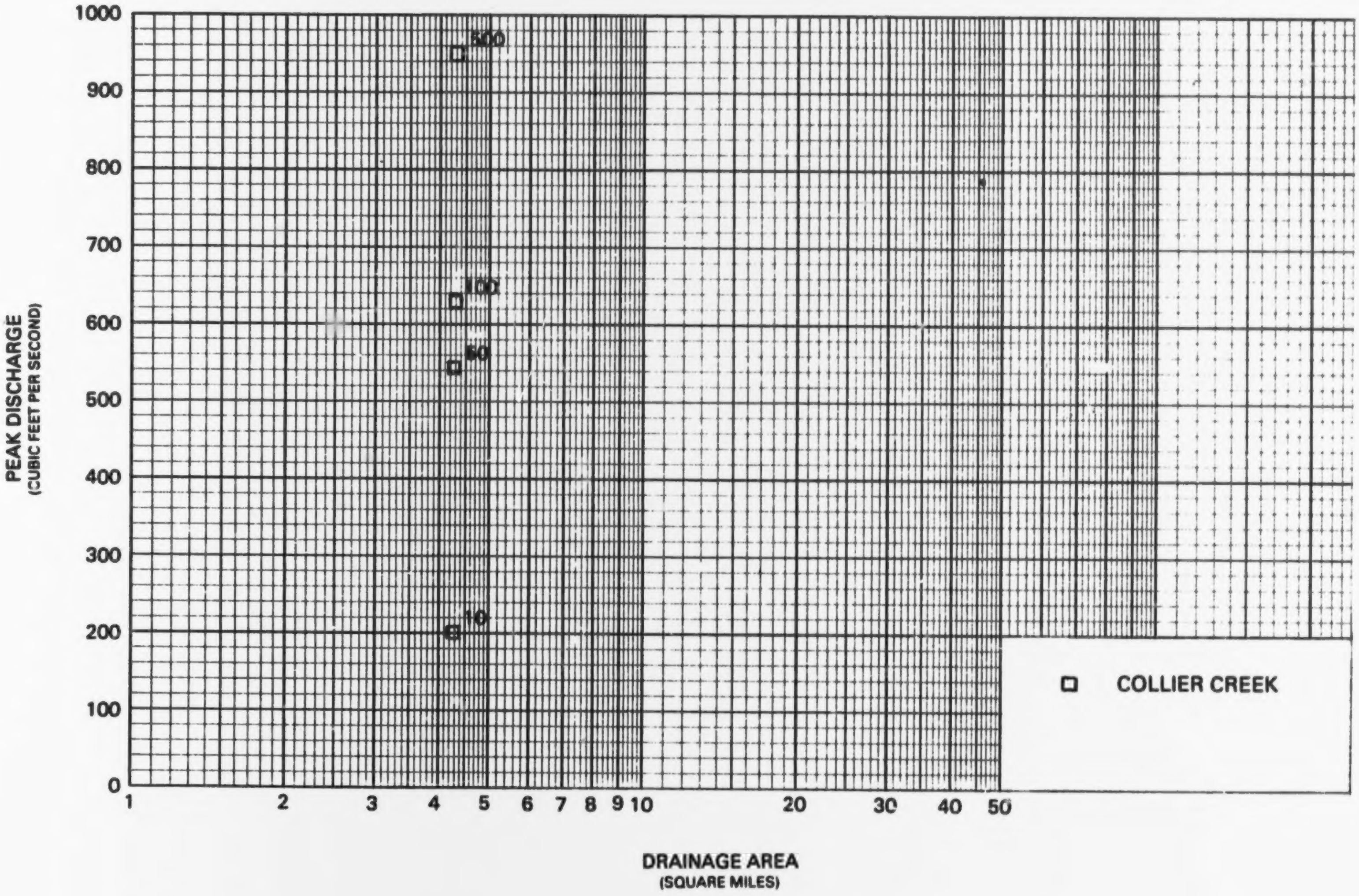


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

COLLIER CREEK

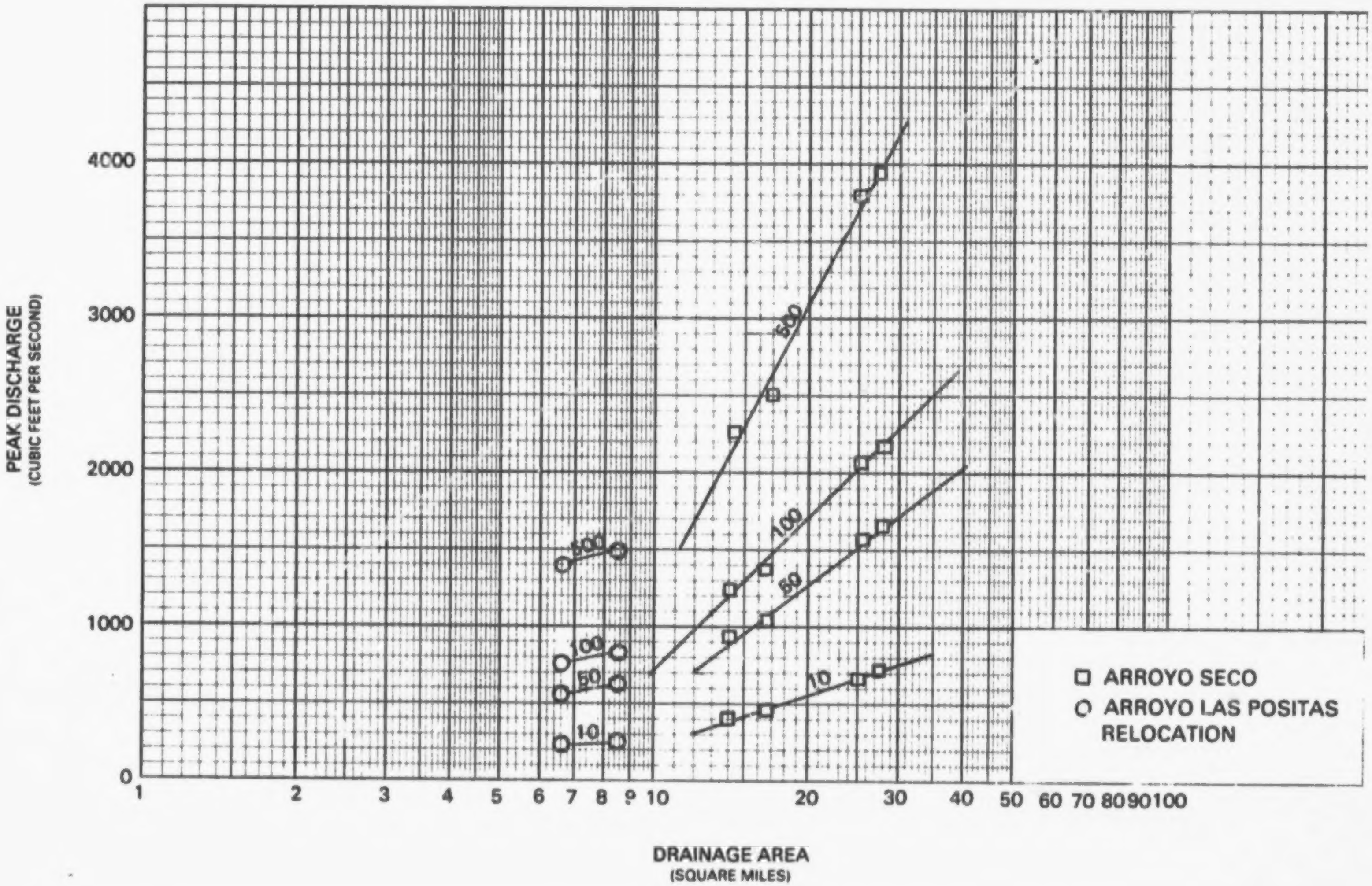


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ARROYO SECO, ARROYO LAS POSITAS RELOCATION

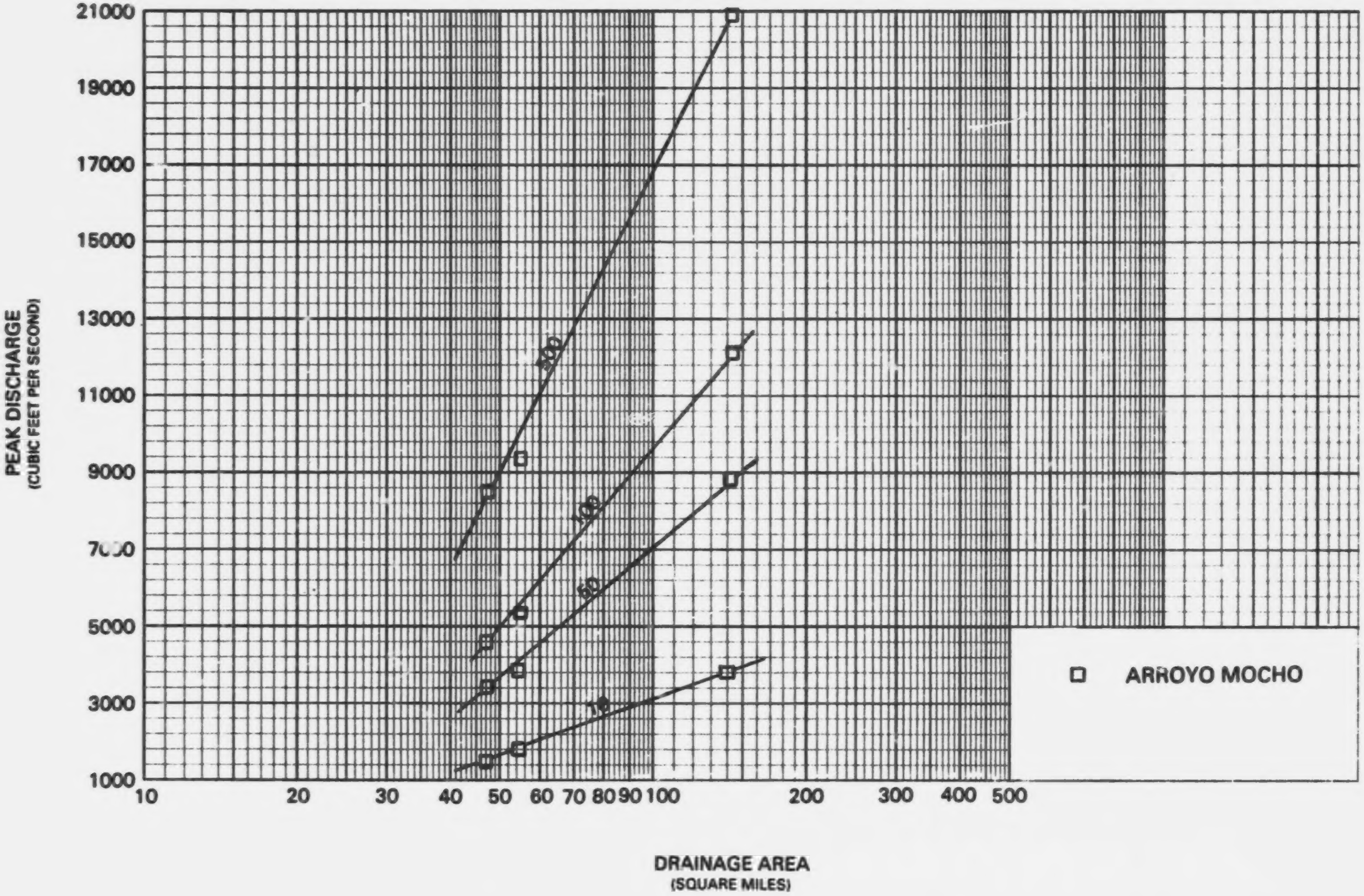


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ARROYO MOCHO

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Each of the streams within the city was analyzed to determine the flood water profile or water-surface elevation at peak flow for floods with recurrence intervals of 10, 50, 100, and 500 years. In the hydraulic analyses, the following steps were taken:

1. A field reconnaissance was conducted to investigate stream channels, obvious problem areas, channel and overbank roughness, flow restrictions, and structures such as bridges, culverts, and levees.

2. Available topographic mapping and stream cross sections were reviewed and additional field surveys were conducted where necessary to adequately define the stream channels and adjacent lands.

3. As-built construction plans for all water control structures, channel modifications, bridges, culverts, and other facilities were compiled.

4. A complete physical description of each stream channel was prepared.

5. Controlling water-surface elevations were determined.

6. Water-surface profiles were computed for each of the recurrence intervals.

Additional cross sections were used to define bridges, culverts, and certain channel constrictions. They are not shown on the map.

Water-surface profiles were computed through the use of the COE computer program (Reference 10). Use of the computer model was supplemented with hand calculations in certain localized areas where such methods were considered to be more suitable.

The Manning flow formula was the basis for hydraulic computations. Channel roughness factors for channels and overbank areas (Manning's "n") were estimated based on field observations, review of photographs, review of previous studies, and comparison with other areas. Roughness coefficients used vary from 0.015 to 0.040 in channels and from 0.035 up to 0.090 in overbank areas.

Water-surface profiles for the streams in the City of Livermore are shown on the Flood Profiles (Exhibit 1).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 3).

4.0 FLOODPLAIN MANAGEMENT APPLICATION

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

The City of Livermore recognizes the need for floodplain management in its General Plan (Reference 1). The plan's space objective is

> to restrict or control urban development in areas of natural hazard which includes earthquake faults, flood plains, steep slopes, fire-prone areas, areas below dams and areas of ancestral slides.

Regarding floodplains and water courses, the report states:

> The city recognizes that the Valley's waterways are almost the only open spaces of natural beauty within the urban area. Their preservation in their natural state as open space and as areas of natural beauty shall be carefully planned so that their limited use for flood control and storm run-off purposes does not take precedent over the greater use as potential public open space.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps of various scales (References 11, 12, and 13).

23

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones AE, AO, and X); and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

Upstream of Cross Section I, floodwaters are controlled by the Stanley Boulevard Bridge. Therefore, no floodway was determined for this reach.

Floodway area is also limited in Arroyo Las Positas. Restriction in channel capacity upstream from Airway Boulevard forces the flow to bypass the bridge into a golf course. Consequently, no floodway was determined downstream from Cross Section B. High velocity flow in portions of Arroyo Seco precludes floodway determination.

The City of Livermore has purchased, for open space reserve, a strip of land along one side of Arroyo Mocho. The floodway area included in this strip meets FEMA floodway criteria. From Holmes Street to South L Street, the City has purchased or is purchasing property along Arroyo Mocho. From South L Street to the eastern corporate limits, the stream traverses the City-owned Robertson Park.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated at selected cross sections (Table 1). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3.

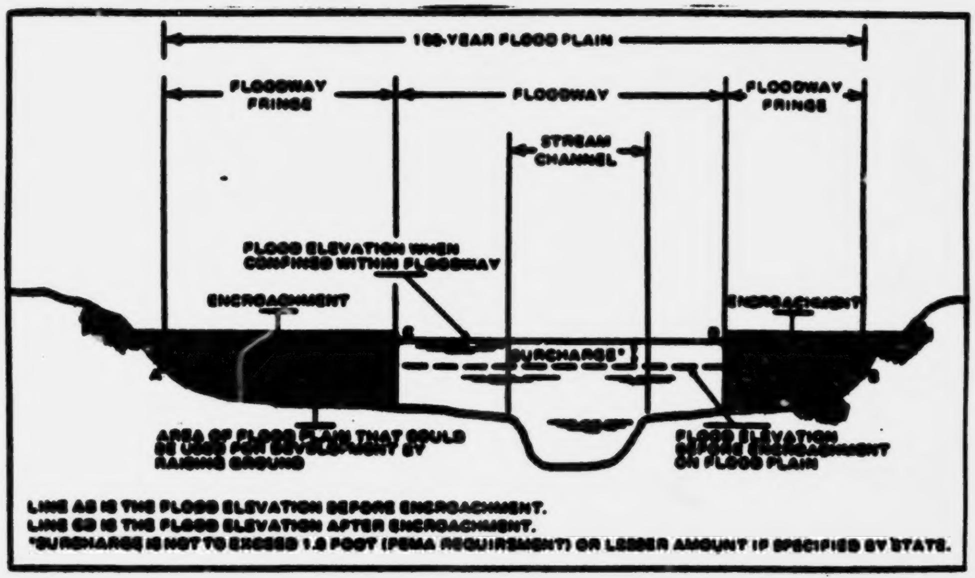

100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
SURCHARGE*
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 3. Floodway Schematic

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Arroyo Mocho								
A	22,047	1,459	5,477	2.0	361.3	361.3	361.6	0.3
B	24,650	1,050	2,196	2.5	363.0	363.0	364.0	1.0
C (Right Bank)	27,633	880	1,372	3.0	374.0	374.0	374.8	0.8
C (Main Channel)	27,633	80	500	2.4	375.0	375.0	376.0	1.0
D (Right Bank)	29,300	700	2,493	0.7	378.5	378.5	379.4	0.9
D (Main Channel)	29,300	100	295	4.0	380.0	380.0	380.0	0.0
E (Right Bank)	32,152	1,006	633	2.5	389.0	389.0	389.9	0.9
E (Left Bank)	32,152	186	189	3.7	391.3	391.3	391.8	0.5
E (Main Channel)	32,152	80	550	5.7	396.2	396.2	396.2	0.0
F	33,350	850	3,042	1.7	402.2	402.2	403.2	1.0
G	35,800	100	525	10.0	415.2	415.2	415.2	0.0[2]
H	39,650	380	1,338	4.0	436.4	436.4	436.4	0.0[3]
I	42,150	154	1,100	4.8	458.0	458.0	458.0	0.0
J	53,500	618	1,329	4.1	541.9	541.9	541.9	0.0

[1] Feet Above Mouth

[2] Floodway is Confined to Main Channel

[3] Overbank Velocity Excessive

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FLOODWAY DATA

ARROYO MOCHO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Arroyo Las Positas								
A	9,500	450	2,260	2.6	371.6	371.6	372.6	1.0
B	20,100	173	1,047	5.2	400.5	400.5	400.9	0.4
C	21,200	140	988	5.6	402.3	402.3	403.1	0.8
D	22,400	123	767	7.2	404.8	404.8	405.8	1.0
E	39,340	154	711	3.2	494.3	494.3	495.3	1.0
F	40,163	70	640	3.6	495.4	495.4	496.4	1.0
G	41,259	68	583	3.9	496.0	496.0	496.9	0.9
H	42,839	223	1,586	1.1	496.7	496.7	497.5	0.8
I	43,039	234	1,626	1.1	496.7	496.7	497.5	0.8
J	43,839	180	1,343	1.3	496.8	496.8	497.6	0.8
K	44,589	332	1,271	1.4	497.2	497.2	497.9	0.7
L	45,776	77	421	0.9	501.3	501.3	502.0	0.7
M	46,286	84	406	0.9	501.6	501.6	502.3	0.7
N	48,043	27	49	7.7	506.8	506.8	506.8	0.0
O	51,767	420	6,969	0.1	527.2	527.2	528.2	1.0

---

[1] Feet Above Mouth

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA COUNTY)

FLOODWAY DATA

ARROYO LAS POSITAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Altamont Creek								
A	200	103	501	3.0	497.1	497.1	498.0	0.9
B	550	102	500	3.0	497.4	497.4	498.2	0.8
C	770	174	889	1.7	497.7	497.7	498.4	0.7
D	1,201	170	867	1.7	498.0	498.0	498.7	0.7
E	1,711	620	1,475	1.0	501.7	501.7	502.4	0.7
F	2,533	865	442	3.4	502.3	502.3	502.9	0.6
G	3,733	1,380	511	2.9	505.5	505.5	506.0	0.5
H	4,828	1,090	238	6.3	508.7	508.7	509.1	0.4
I	5,341	26	139	10.8	511.0	511.0	511.0	0.0
J	6,146	24	119	12.6	512.2	512.2	512.2	0.0
K	7,237	33	121	10.9	518.6	518.6	518.6	0.0
L	7,666	1,750	2,555	0.3	526.4	526.4	527.4	1.0
M	8,264	210	170	4.2	529.6	529.6	530.3	0.7
N	9,084	45	145	5.0	534.6	534.6	535.1	0.5
O	10,044	385	211	3.4	541.5	541.5	542.4	0.9
P	11,000	210	191	3.8	545.9	545.9	546.1	0.2
Q	12,380	102	328	2.2	551.9	551.9	552.8	0.9
R	13,600	30	92	7.8	558.6	558.6	559.1	0.5
S	15,800	198	386	1.9	567.2	567.2	567.4	0.2
T	17,400	61	210	3.4	578.0	578.0	578.6	0.6

---

[1] Feet Above Mouth

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FLOODWAY DATA

ALTAMONT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Arroyo Seco								
A	7,319	1,372[2]	7,778	0.2	535.5	535.5	536.5	1.0
B	8,619	45	148	9.3	540.2	540.2	541.2	1.0
C	9,920	45	1,742	0.7	549.5	549.5	550.5	1.0[3]

[1] Feet Above Mouth
[2] Width Shown Without Consideration of Floodway for Arroyo Las Positas
[3] Floodway is Confined to Main Channel

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FLOODWAY DATA

ARROYO SECO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Arroyo Las Positas Relocation								
A	1,000	150	866	0.9	535.5	535.5	535.5	0.0
B	1,760	65	110	7.5	539.5	539.5	539.5	0.0
C	3,000	176	302	2.7	548.2	548.2	549.0	0.8
D	4,000	140	300	2.7	552.8	552.8	553.8	1.0
E	8,300	150	225	3.6	575.3	575.3	576.3	1.0
F	10,300	17	79	10.4	589.4	589.4	590.4	1.0[2]

[1] Feet Above Mouth

[2] One Foot Above Right Bank Elevation 591.5 Feet

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA COUNTY)

FLOODWAY DATA

ARROYO LAS POSITAS RELOCATION

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Arroyo Del Valle								
A	39,250	150	769	9.1	443.0	443.0	443.7	0.7

[1] Feet Above Confluence With Arroyo De La Laguna

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA COUNTY)

FLOODWAY DATA

ARROYO DEL VALLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Cayetano Creek								
A	5,670	89	145	6.6	479.2	479.2	479.2	0.0
B	9,000	89	217	4.4	505.2	505.2	506.2	1.0[2]

[1] Feet Above Mouth

[2] Floodway Stays Outside Main Channel

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA COUNTY)

FLOODWAY DATA

CAYETANO CREEK

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheetflow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

A flood control report was prepared for the Alameda Creek watershed by the COE in 1961 (Reference 4). In that report the Standard Project Storm flow for Area 6, which includes most of the City of Livermore, was shown to be 20 percent higher than the value determined for the same area by the initial Flood Insurance Study. An error in the Area 6 unit graph of the 1961 report was found, which accounted for most of the difference in values.

In the 1961 report by the COE, Area 7, which contains the northern edge of the city, was shown to have a Standard Project Storm flow 8 percent higher than that found for the same area in the present Flood Insurance Study. For the purposes of the initial study, this 8 percent difference was small enough that the two values for the Standard Project Storm flow in Area 7 were considered in agreement.

The data presented in this study either supersede or are compatible with all previous determinations.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Presidio of San Francisco, Building 105, San Francisco, California 94129.

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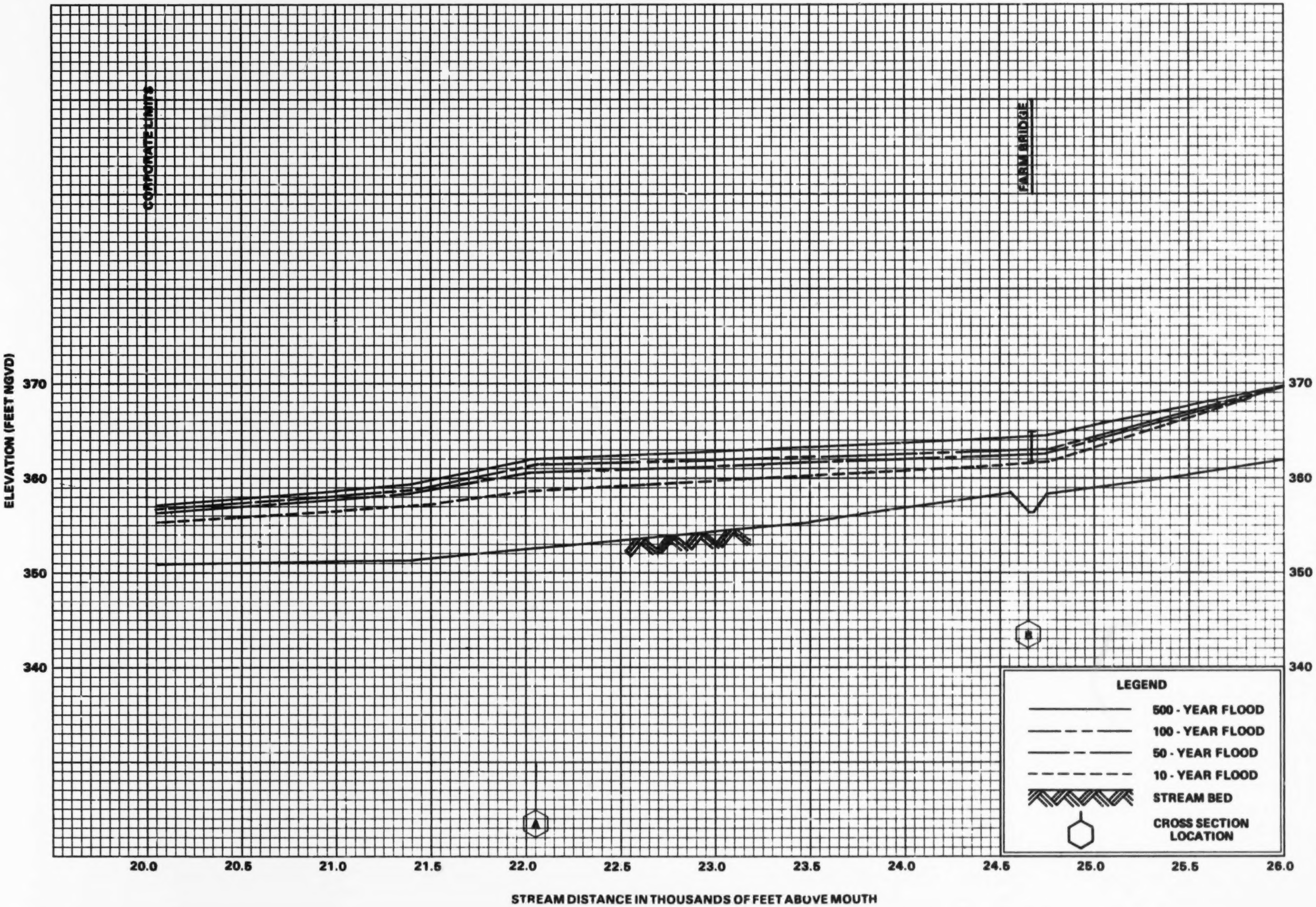


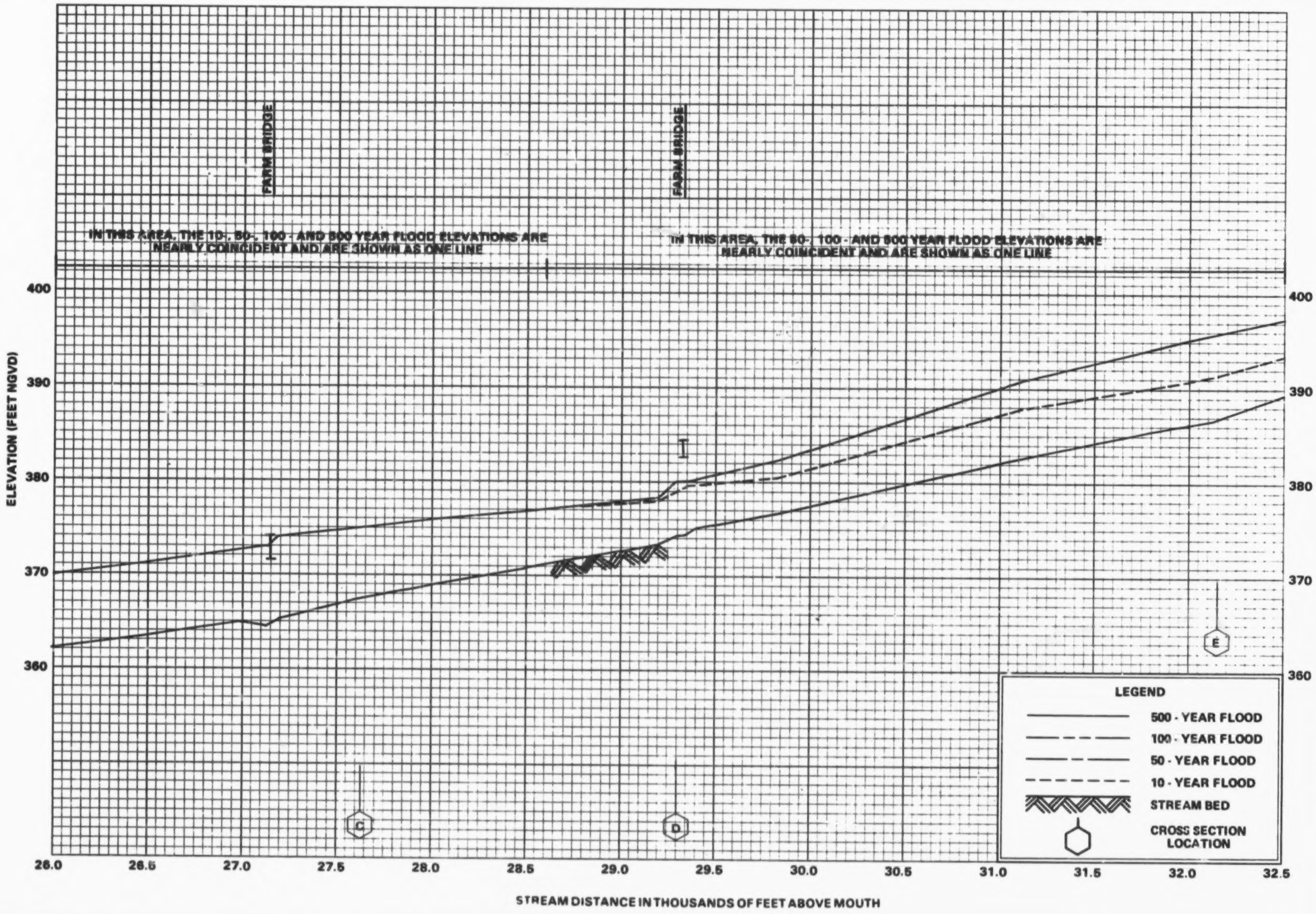
FLOOD PROFILES

ARROYO MOCHO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

01P



FLOOD PROFILES

ARROYO MOCHO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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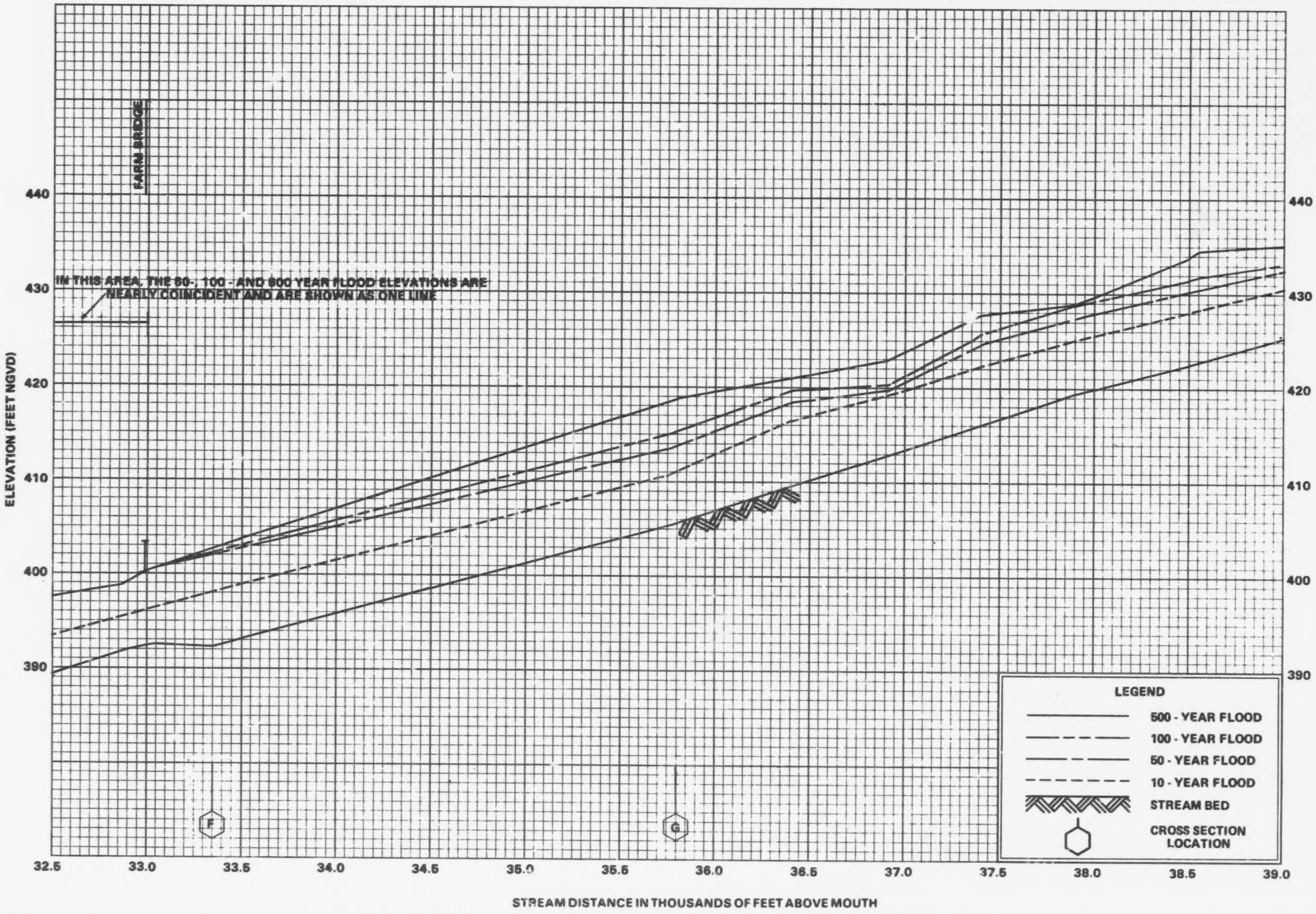

FLOOD PROFILES

ARROYO MOCHO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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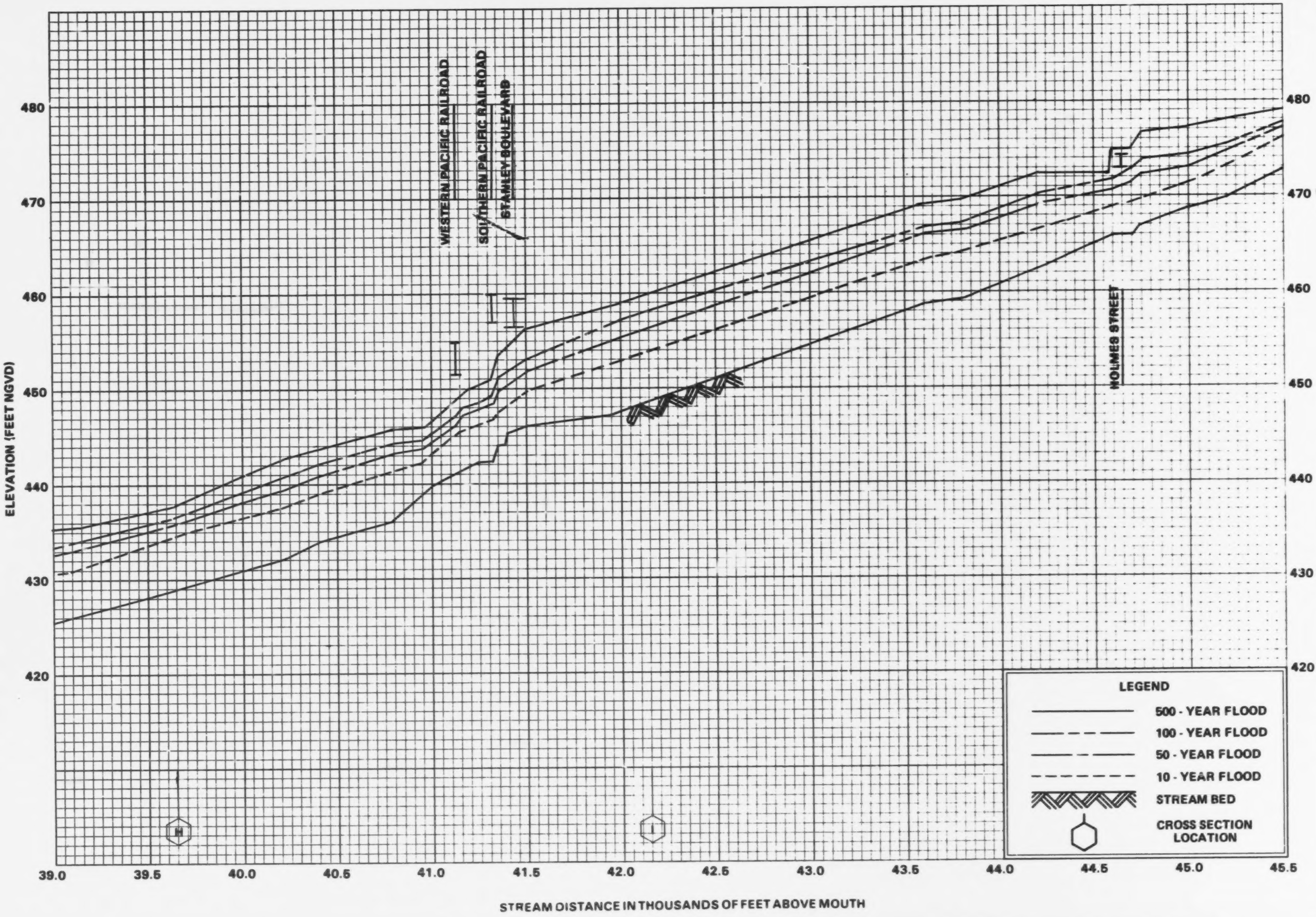

FLOOD PROFILES

ARROYO MOCHO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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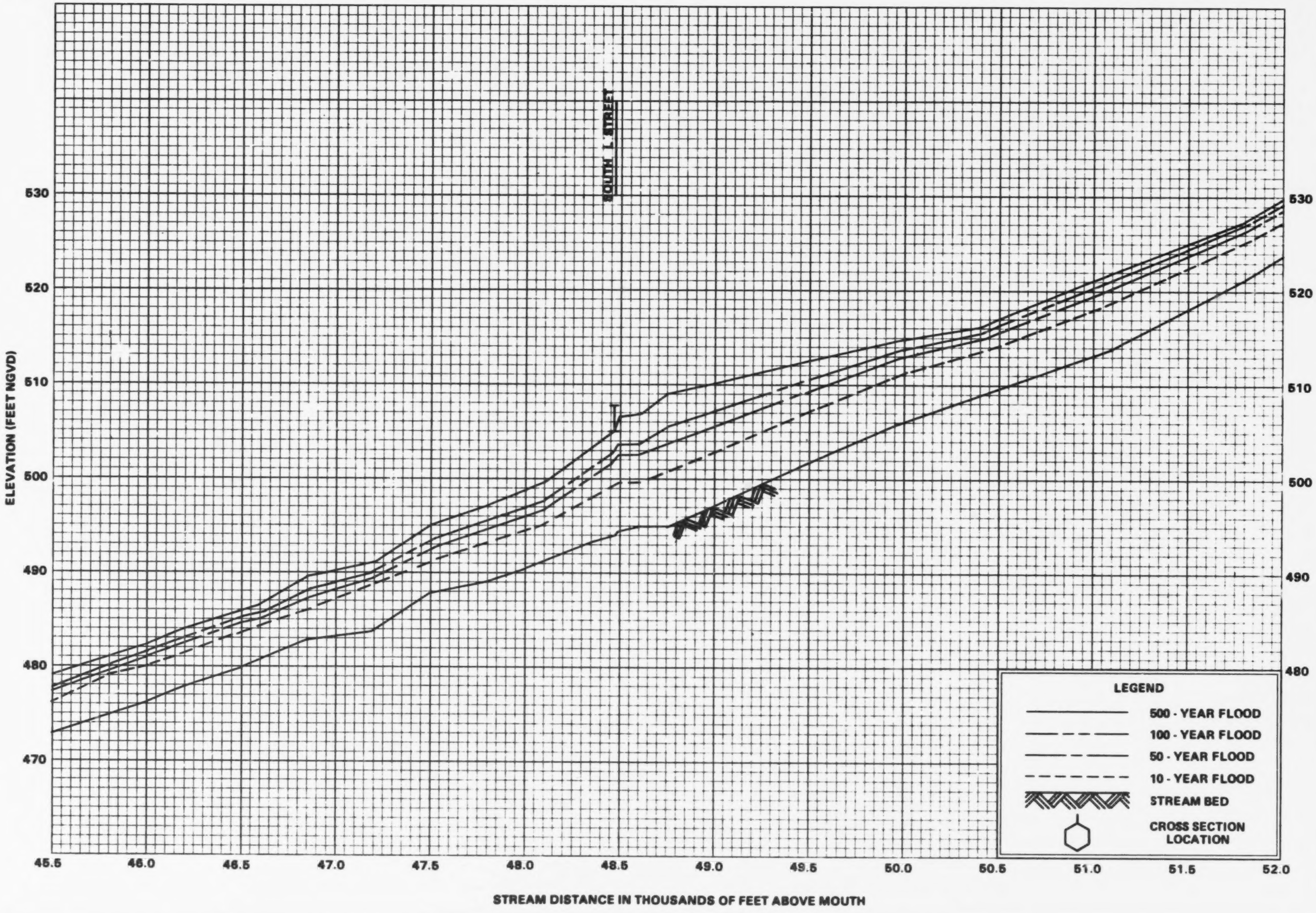

FLOOD PROFILES

ARROYO MOCHO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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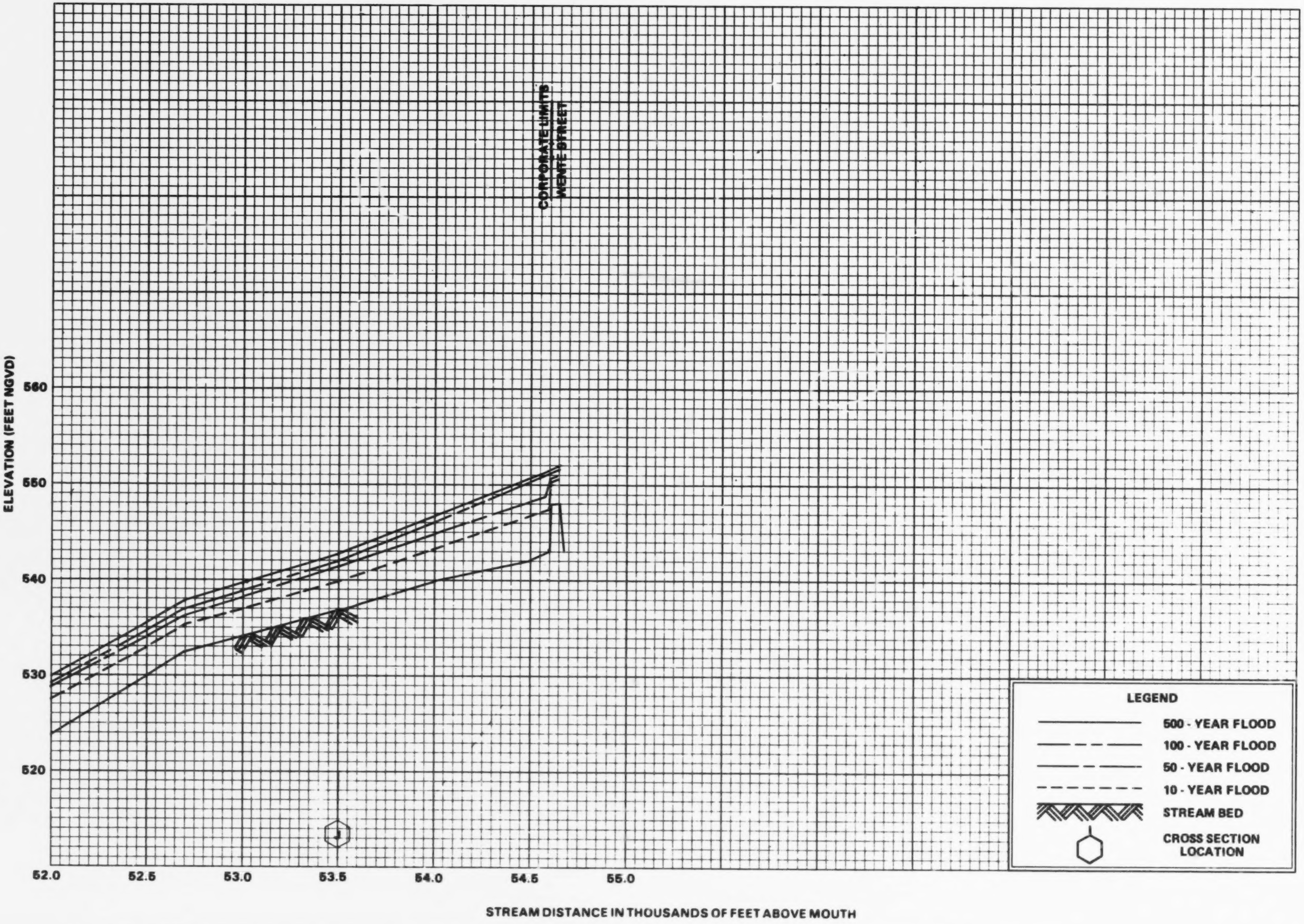

FLOOD PROFILES

ARROYO MOCHO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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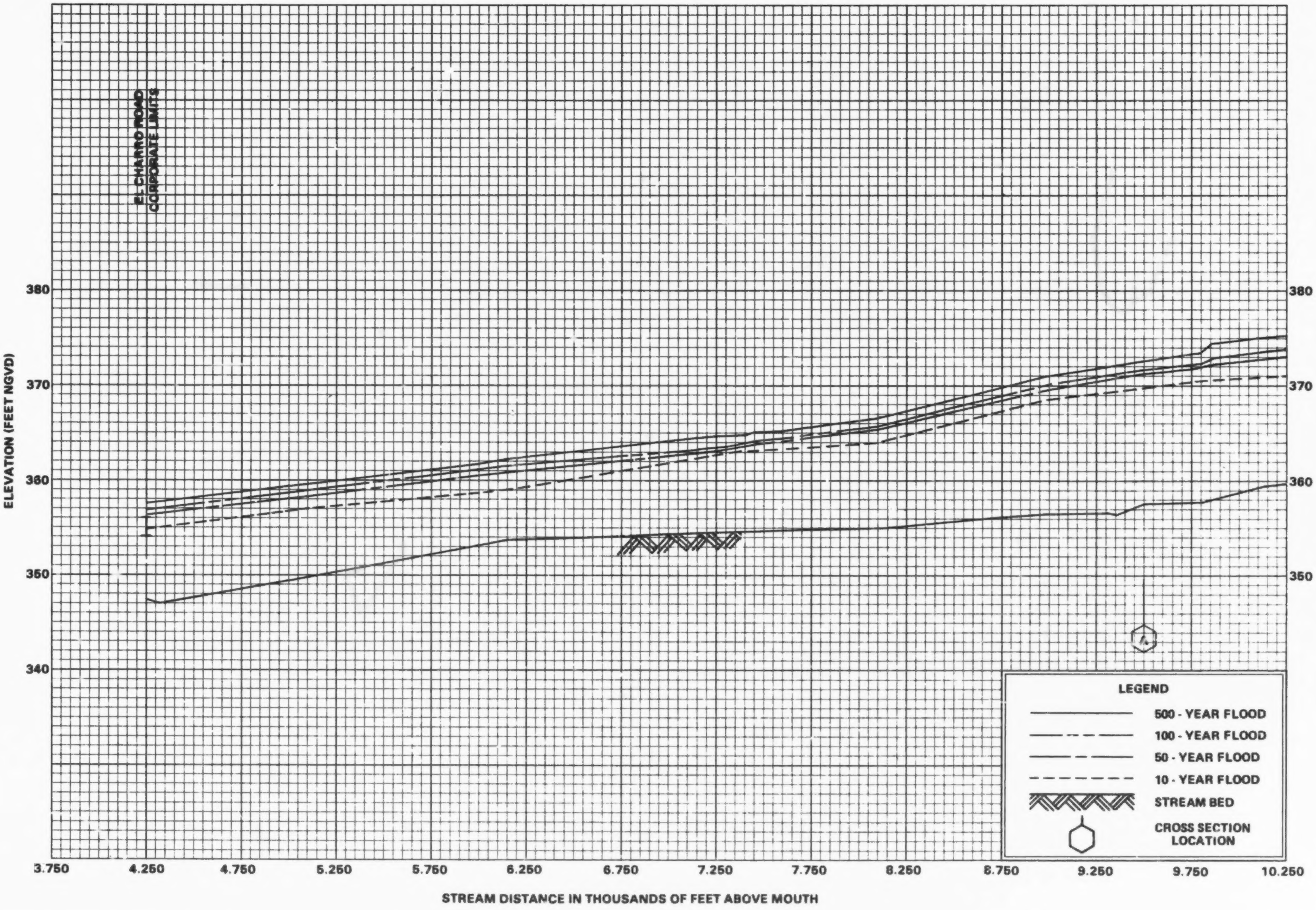

FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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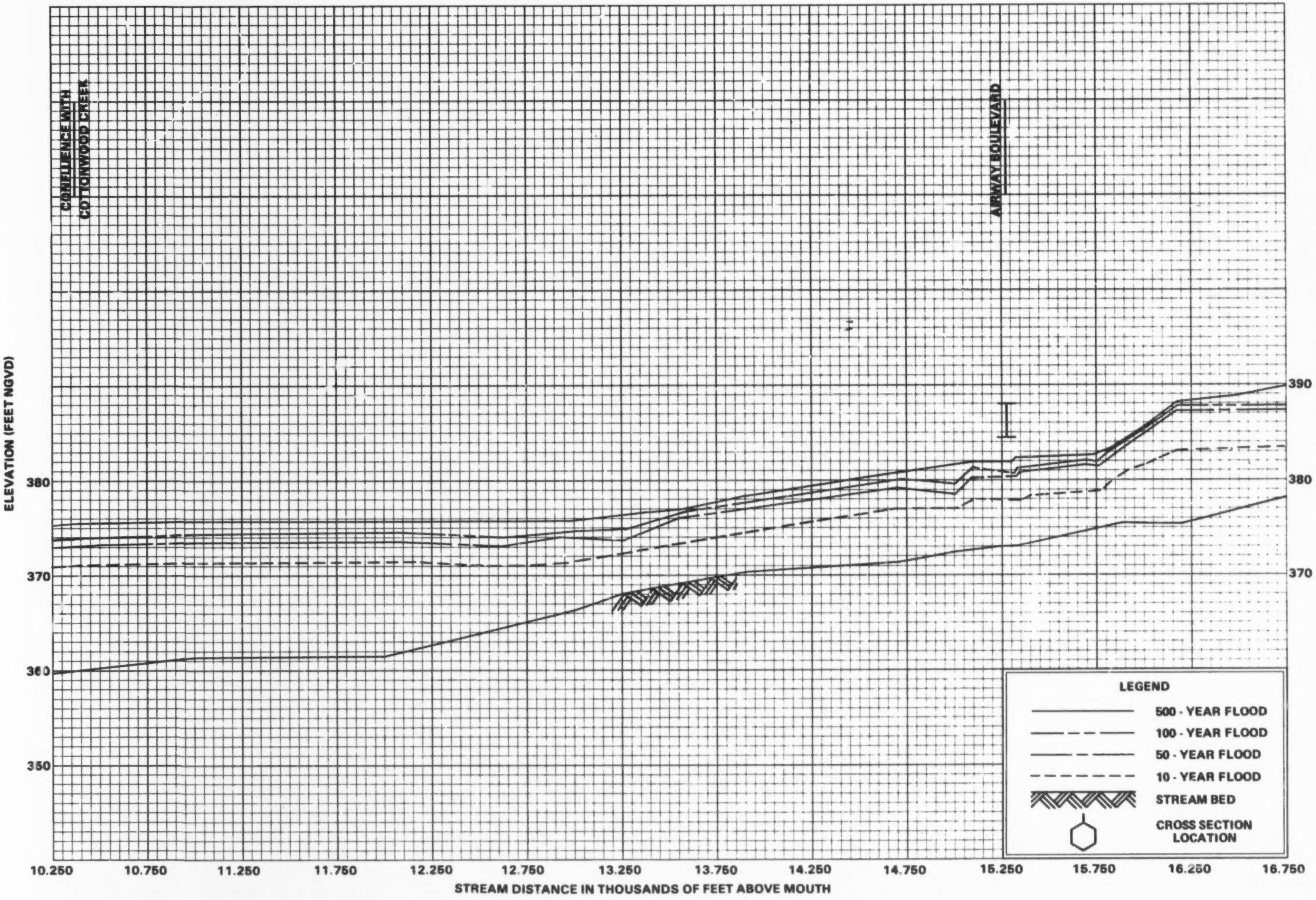

FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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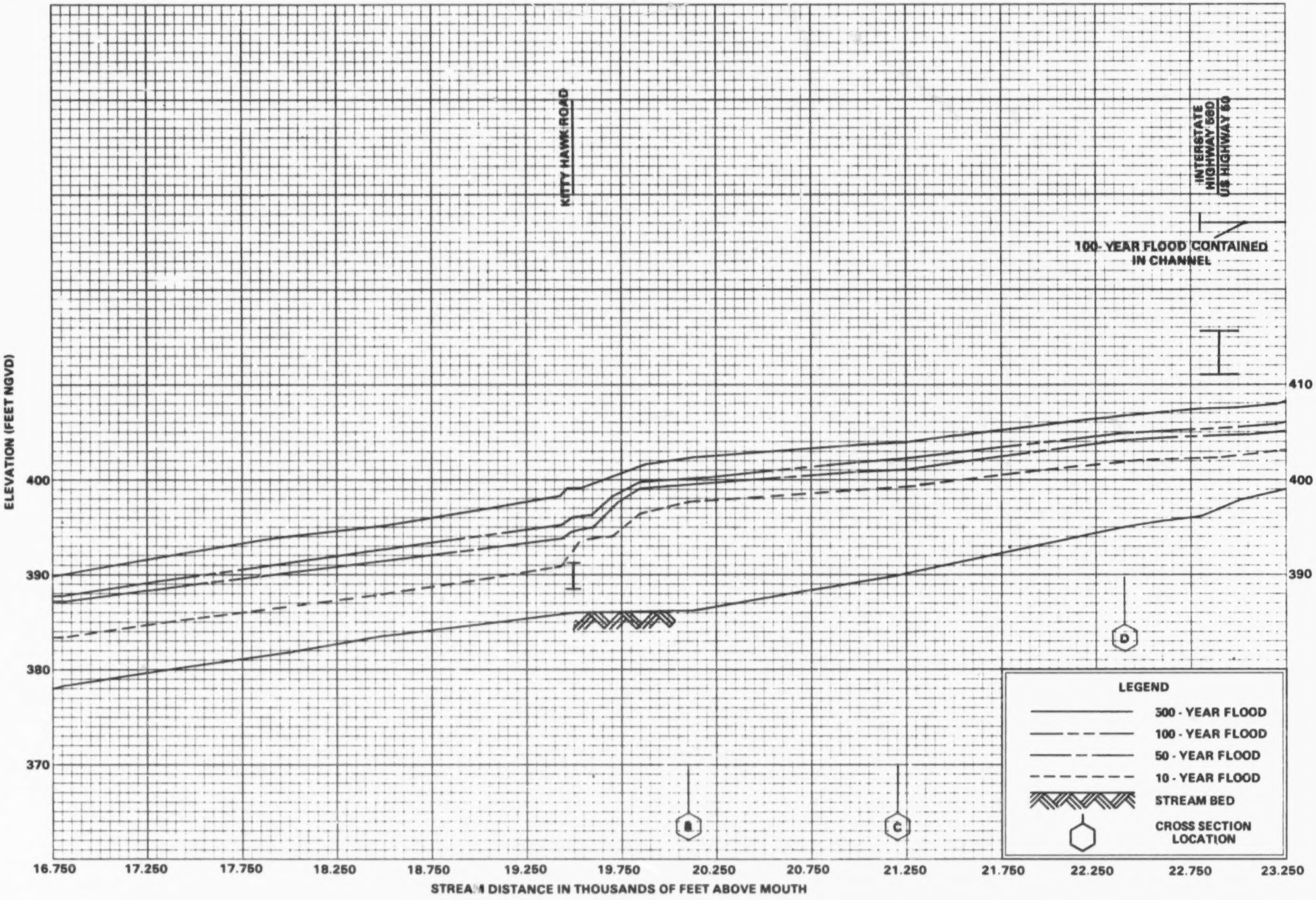

FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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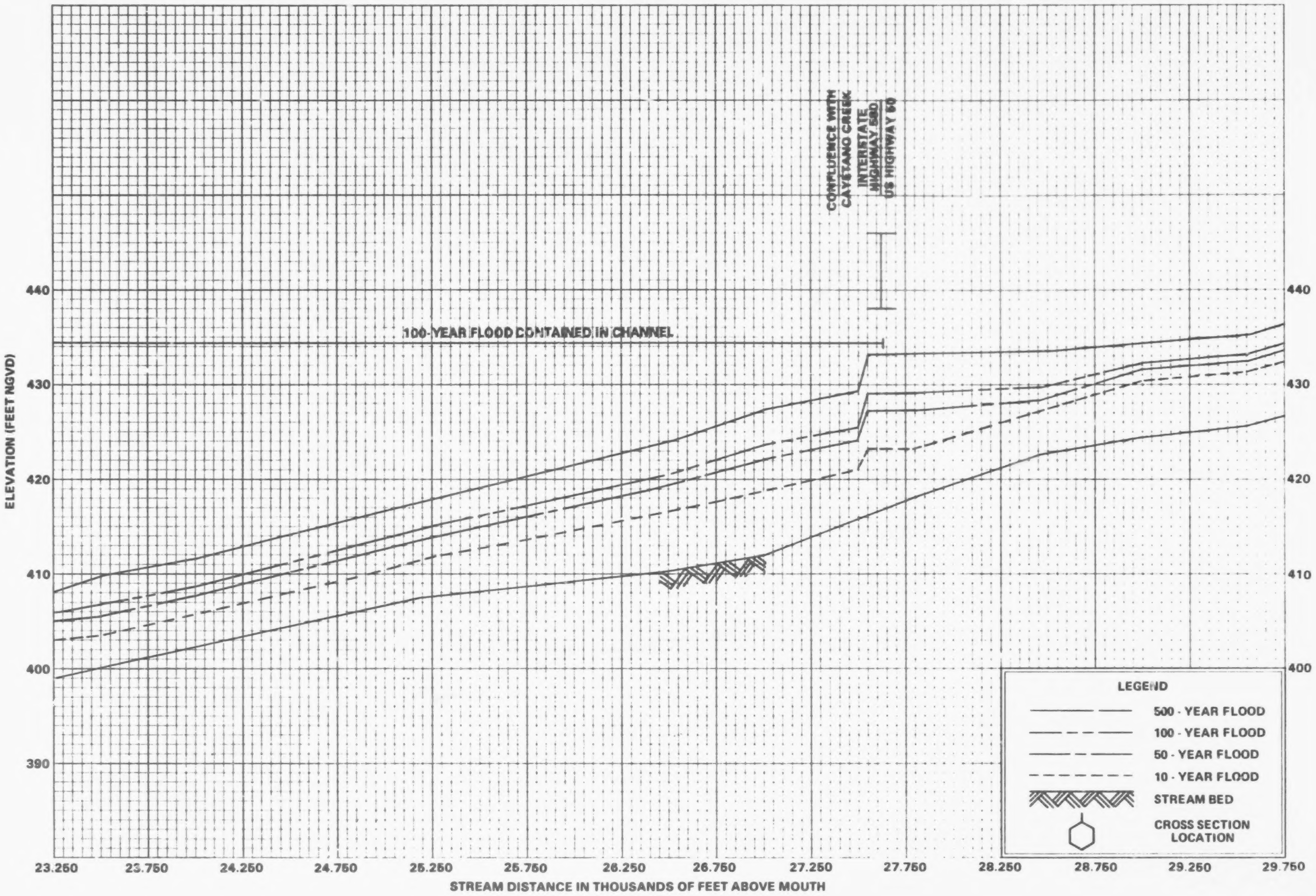

FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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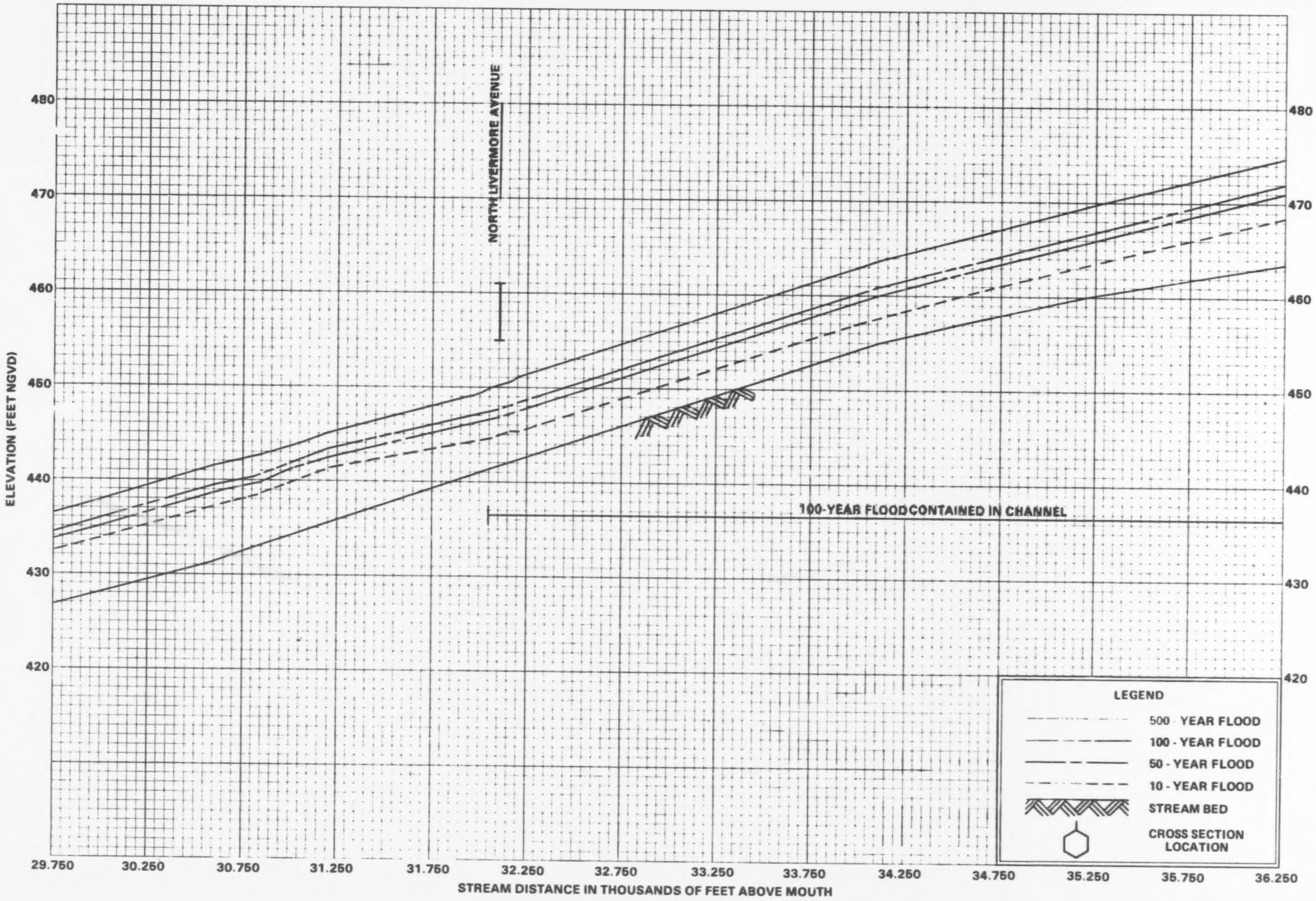

FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

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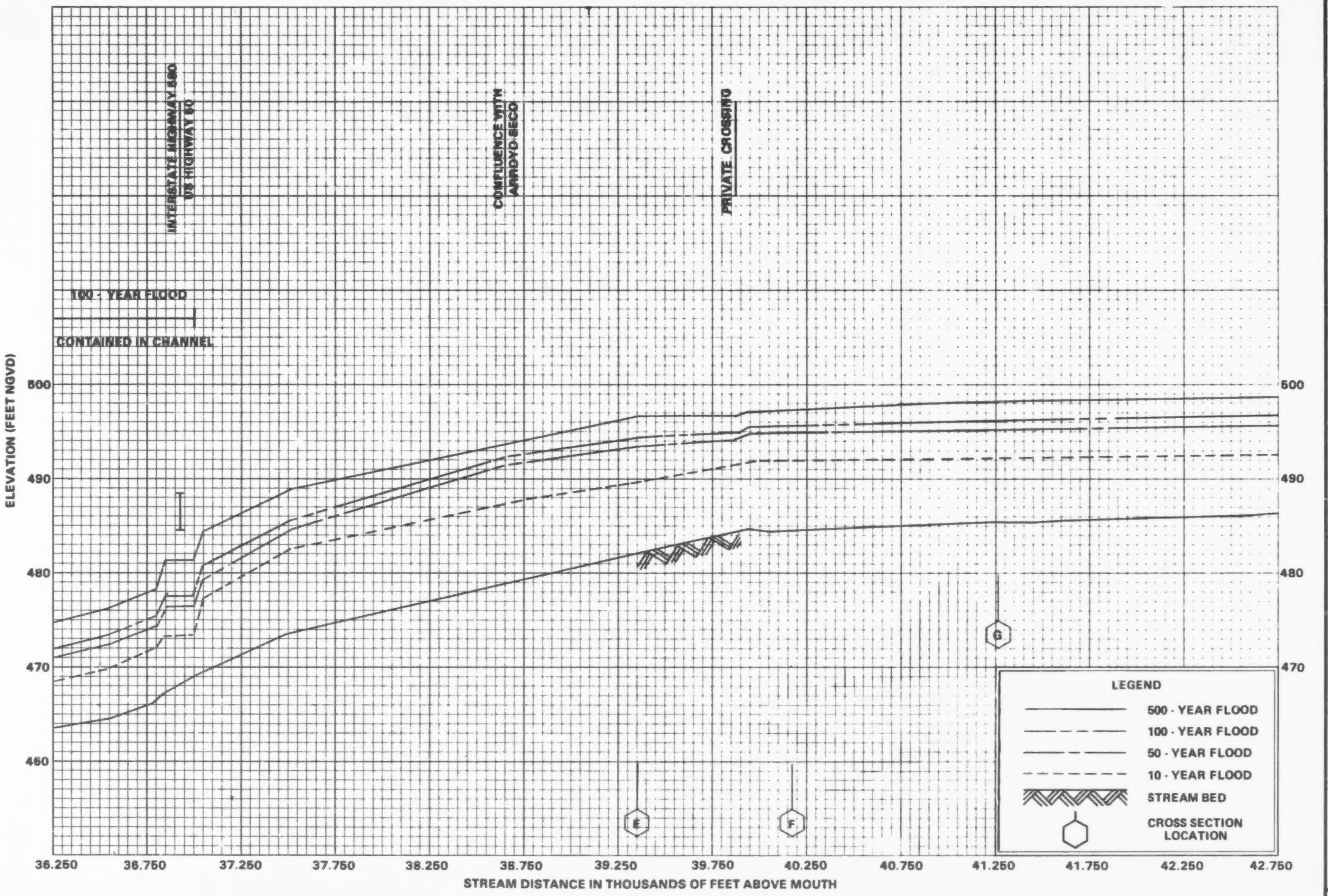


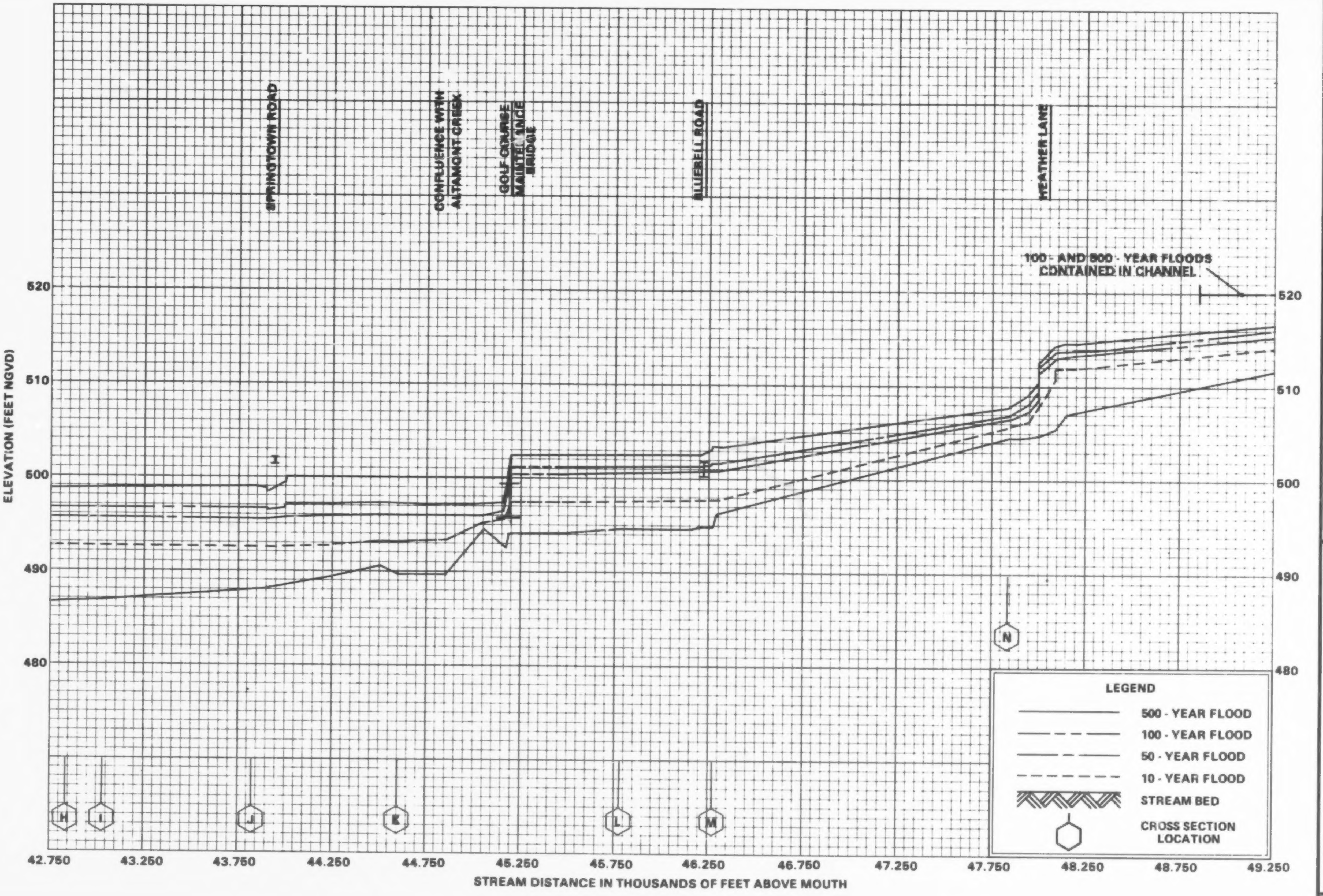
FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)



FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)

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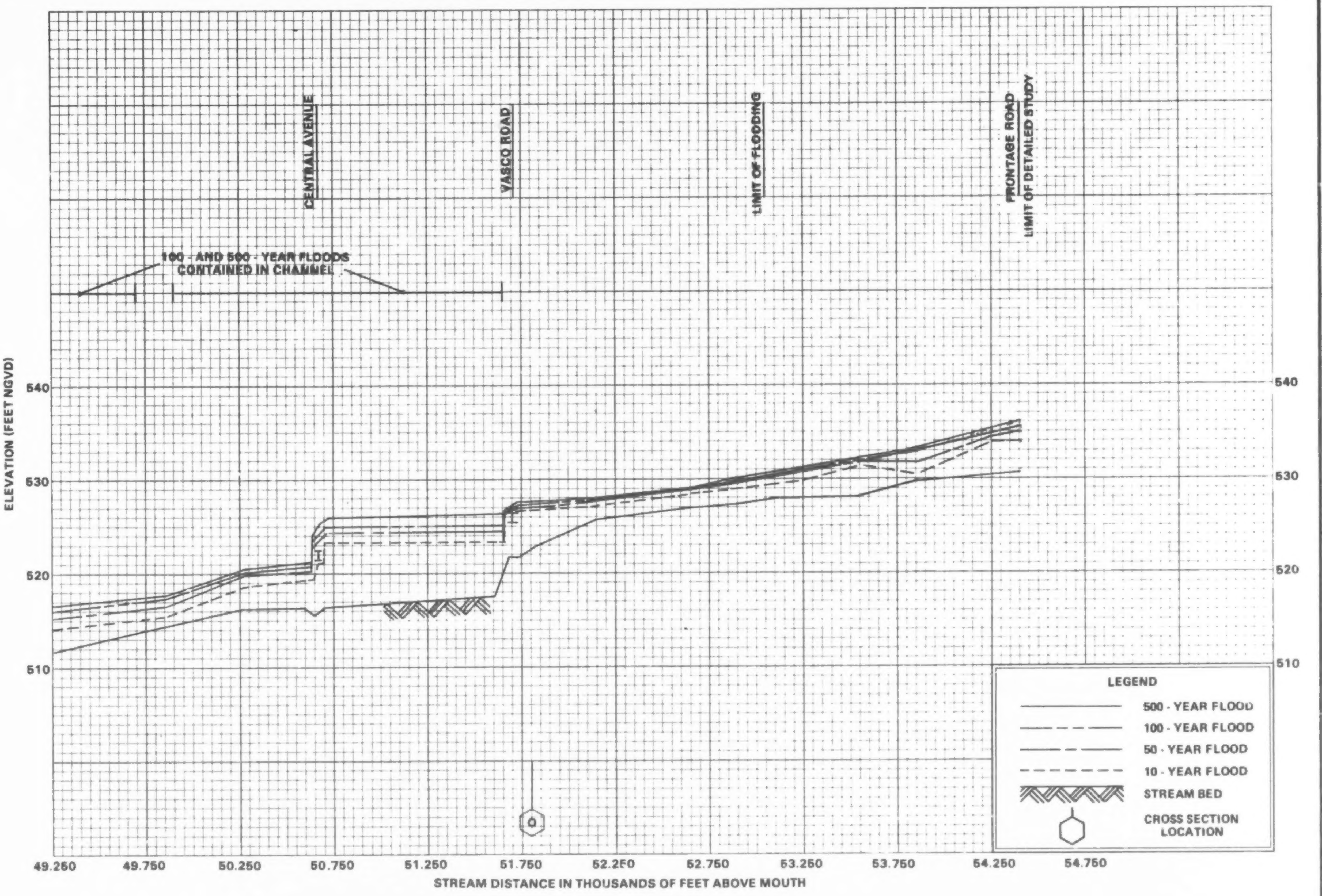
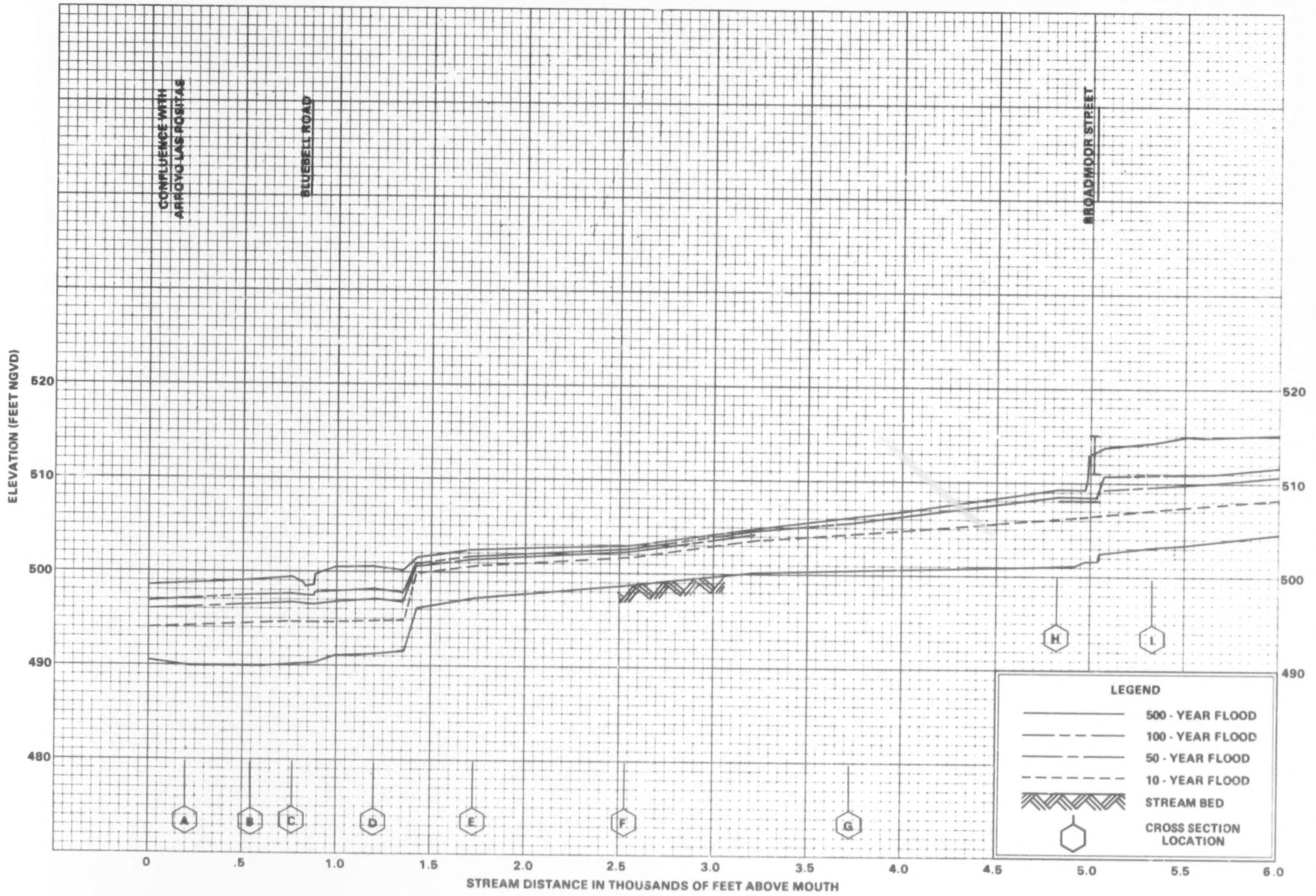


FLOOD PROFILES

ARROYO LAS POSITAS

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF LIVERMORE, CA
(ALAMEDA CO.)

14P



FLOOD PROFILES

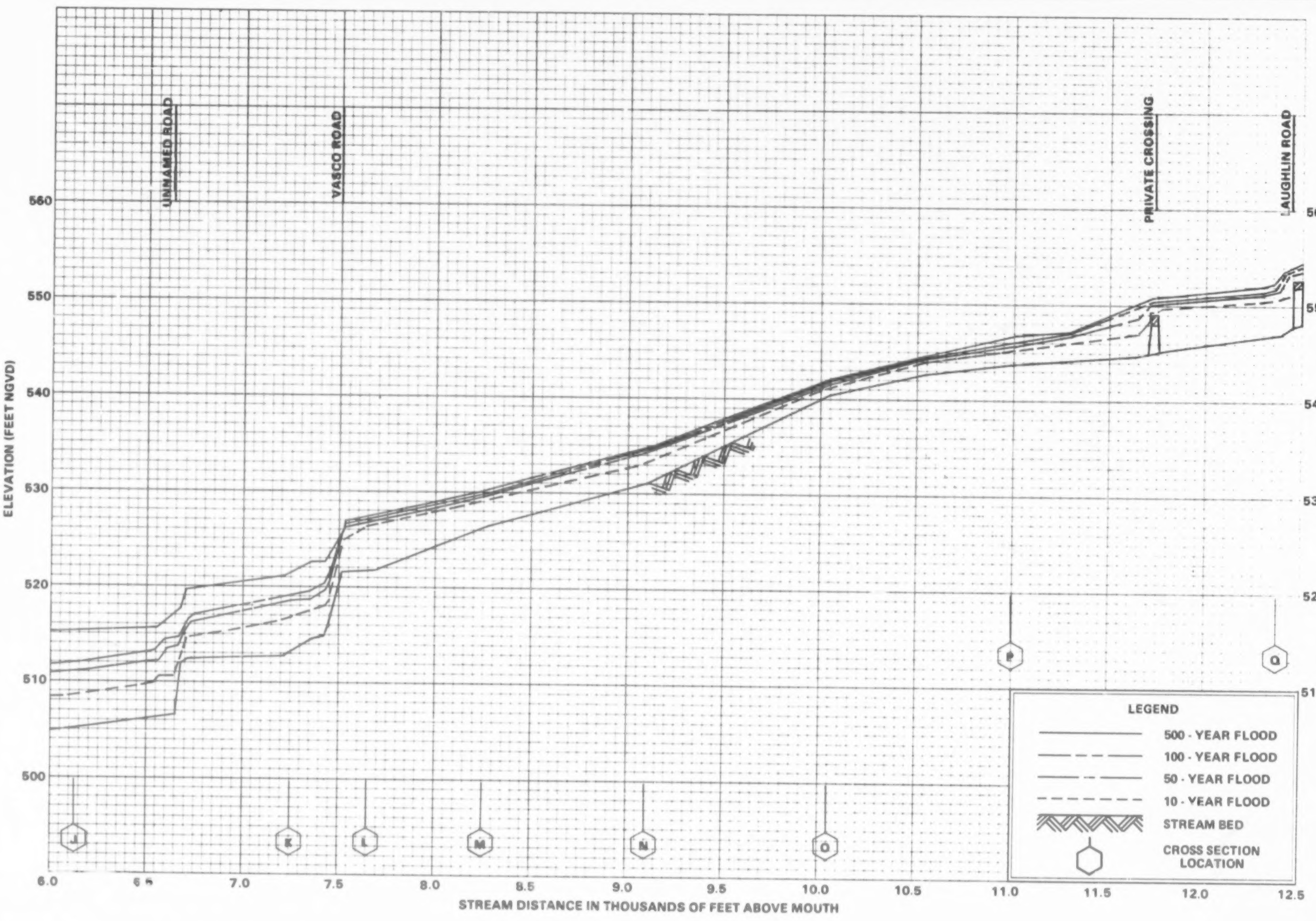
ALTAMONT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)

15P

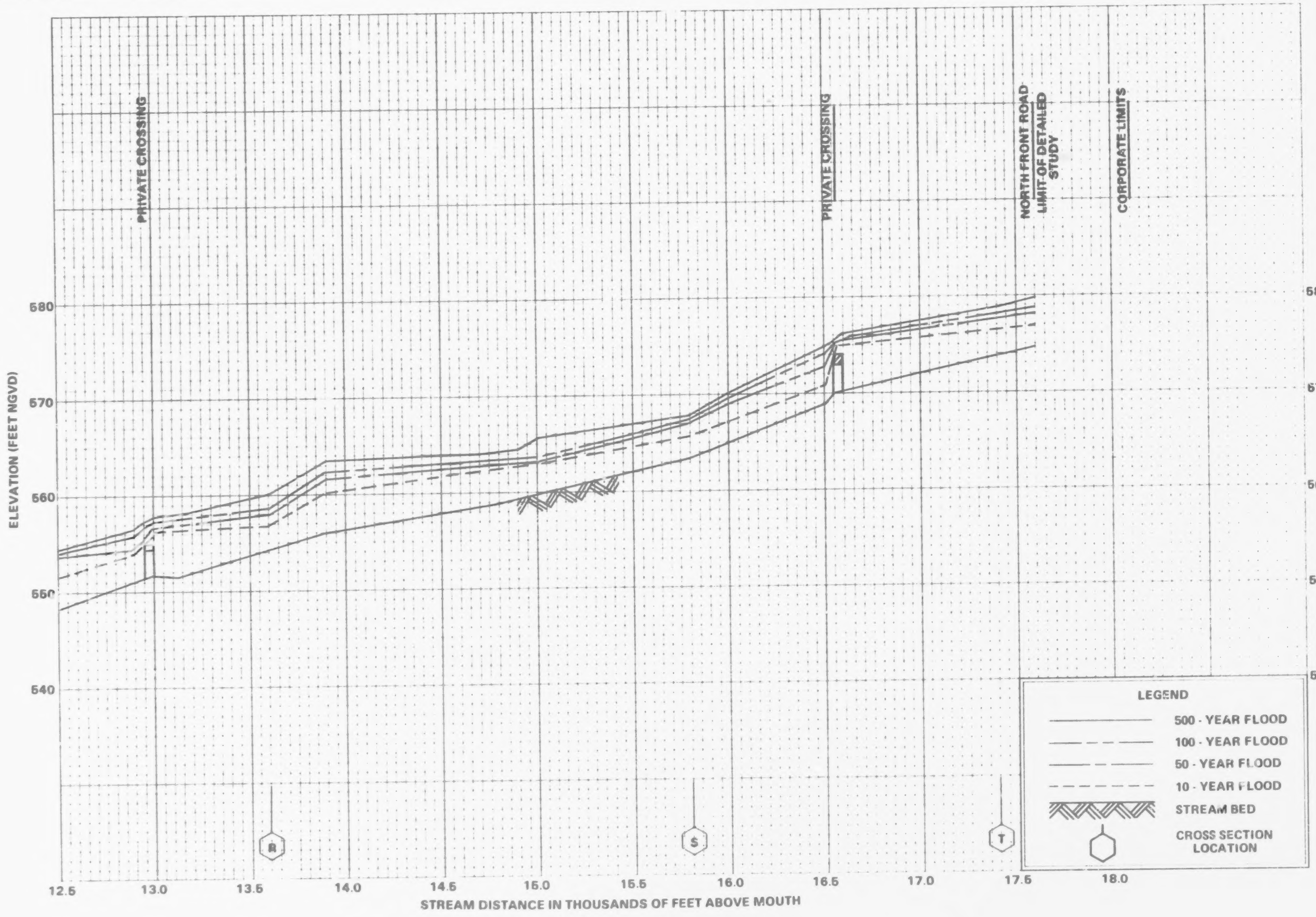


FLOOD PROFILES

ALTAMONT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF LIVERMORE, CA
(ALAMEDA CO.)

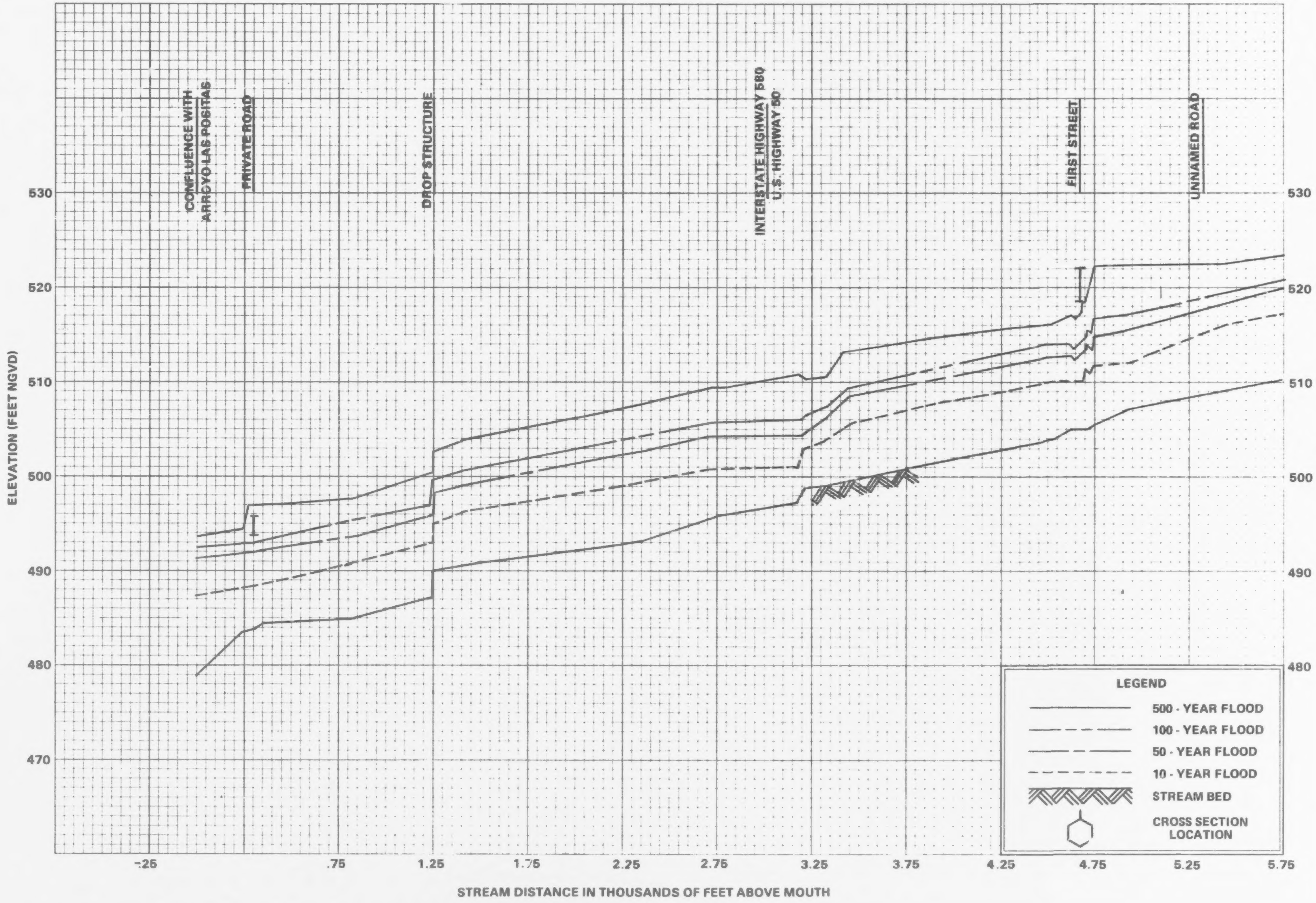
16P



FLOOD PROFILES

ALTAMONT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF LIVERMORE, CA
(ALAMEDA CO.)



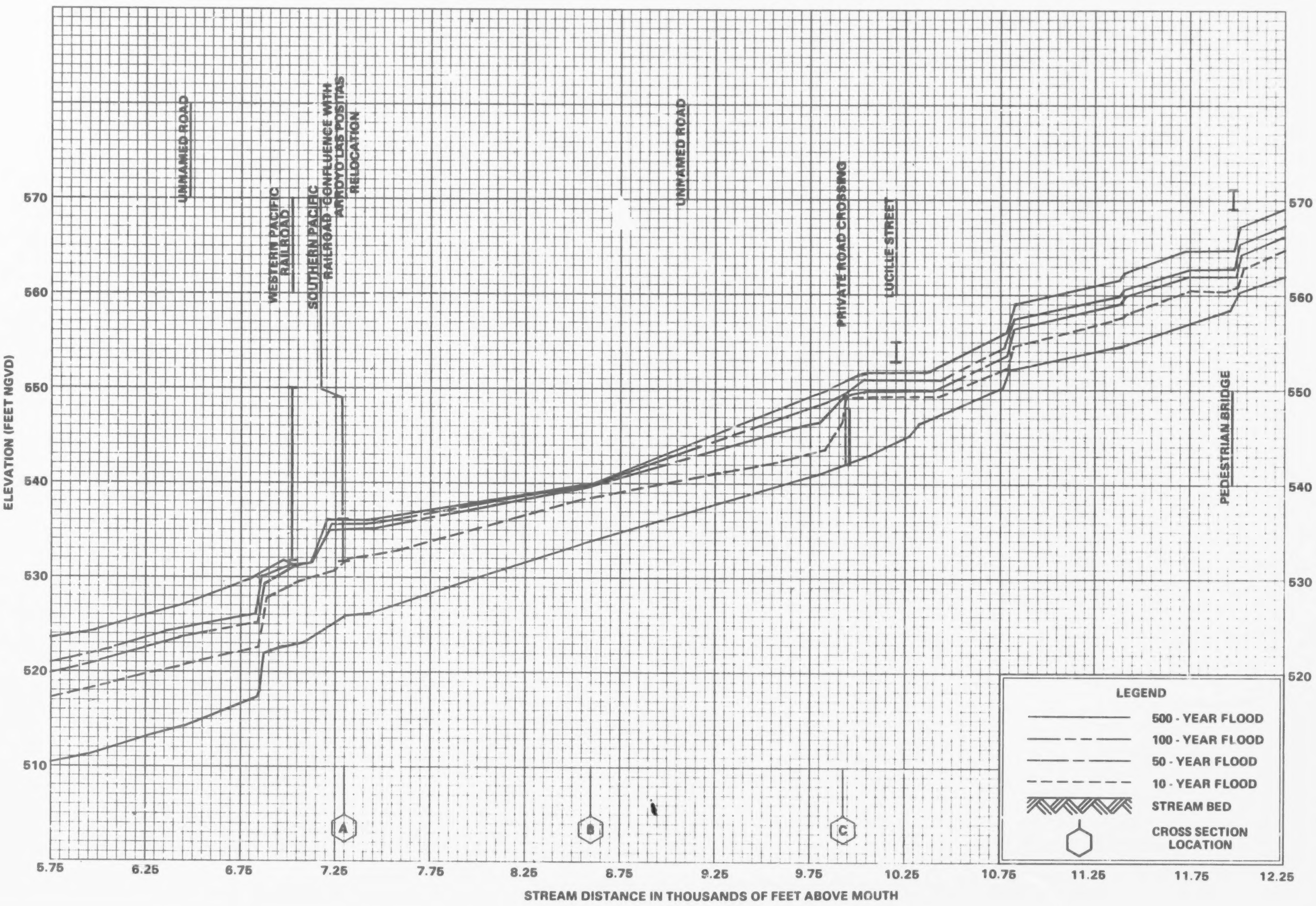
FLOOD PROFILES

ARROYO SECO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

18P

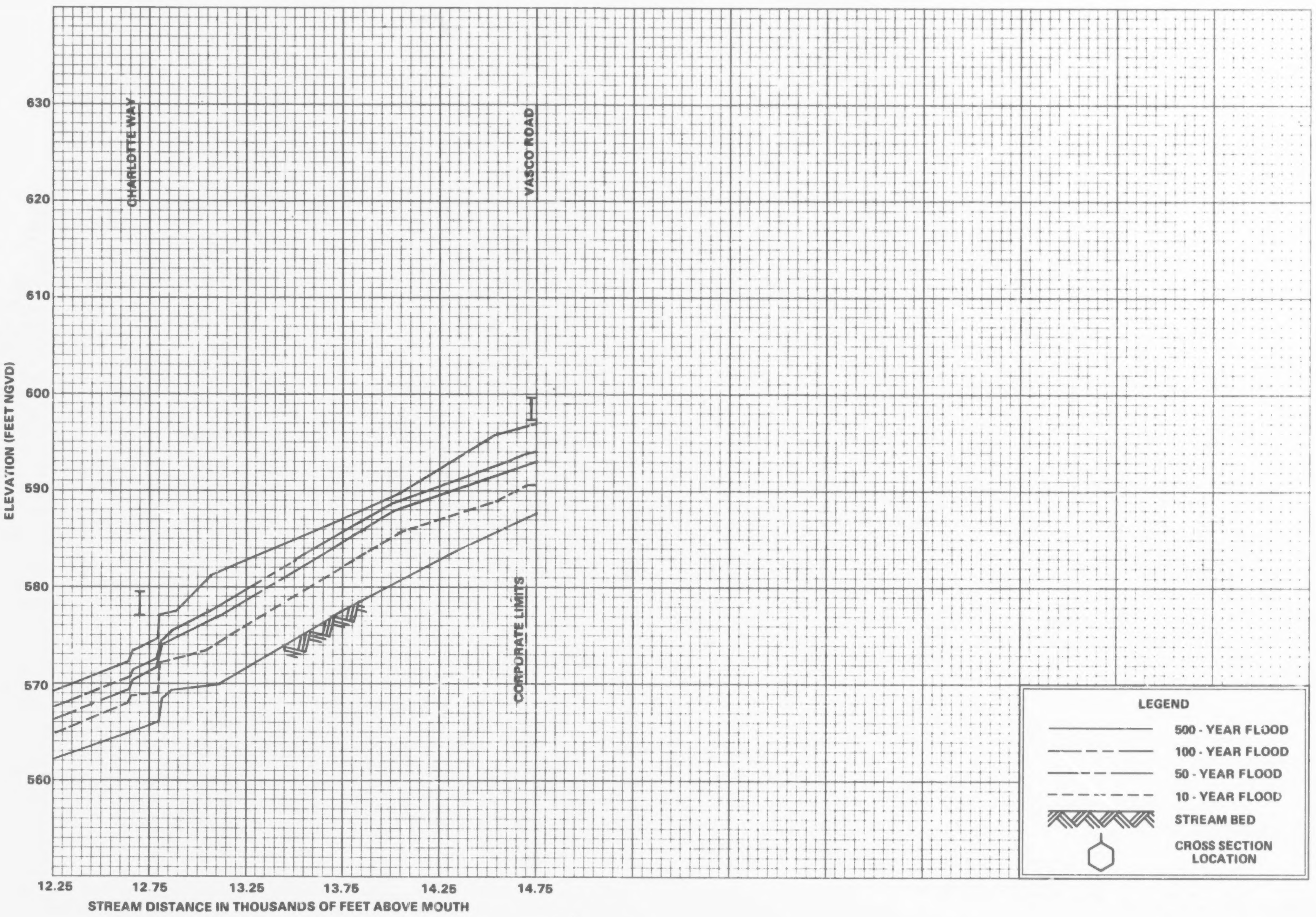


FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

FLOOD PROFILES

ARROYO SECO



FLOOD PROFILES

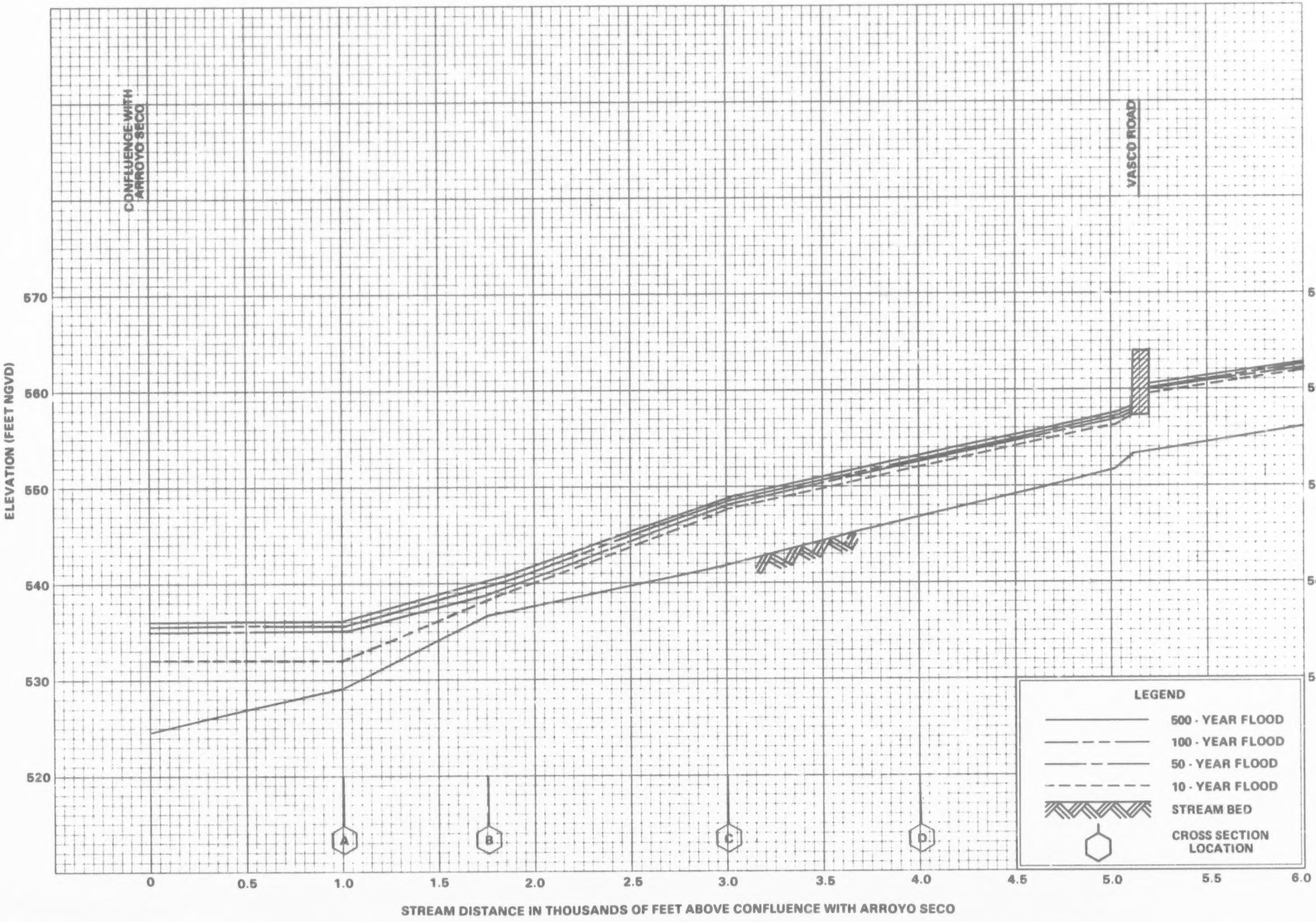
ARROYO SECO

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)

20P



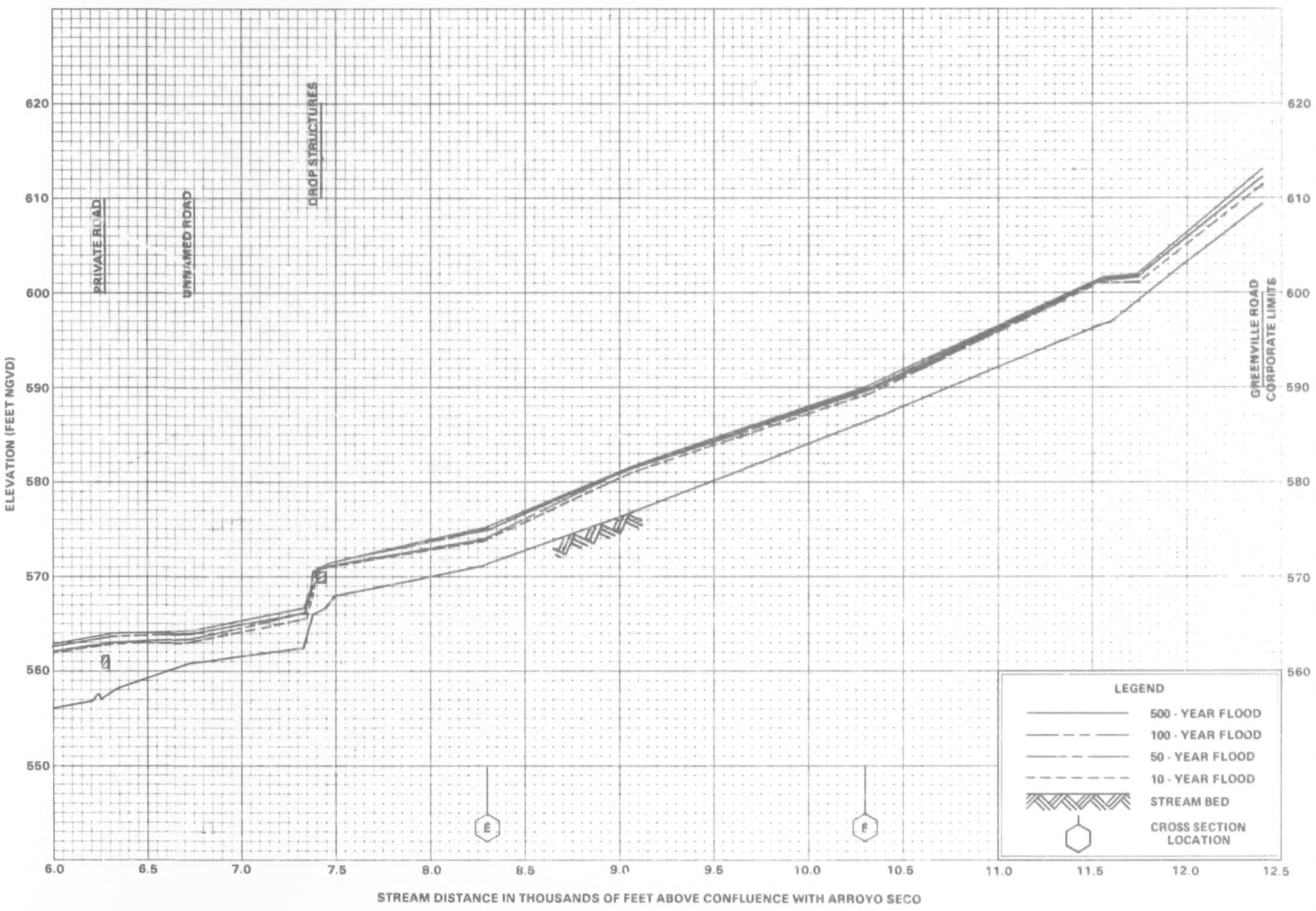
FLOOD PROFILES

ARROYO LAS POSITAS RELOCATION

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

21P



FLOOD PROFILES

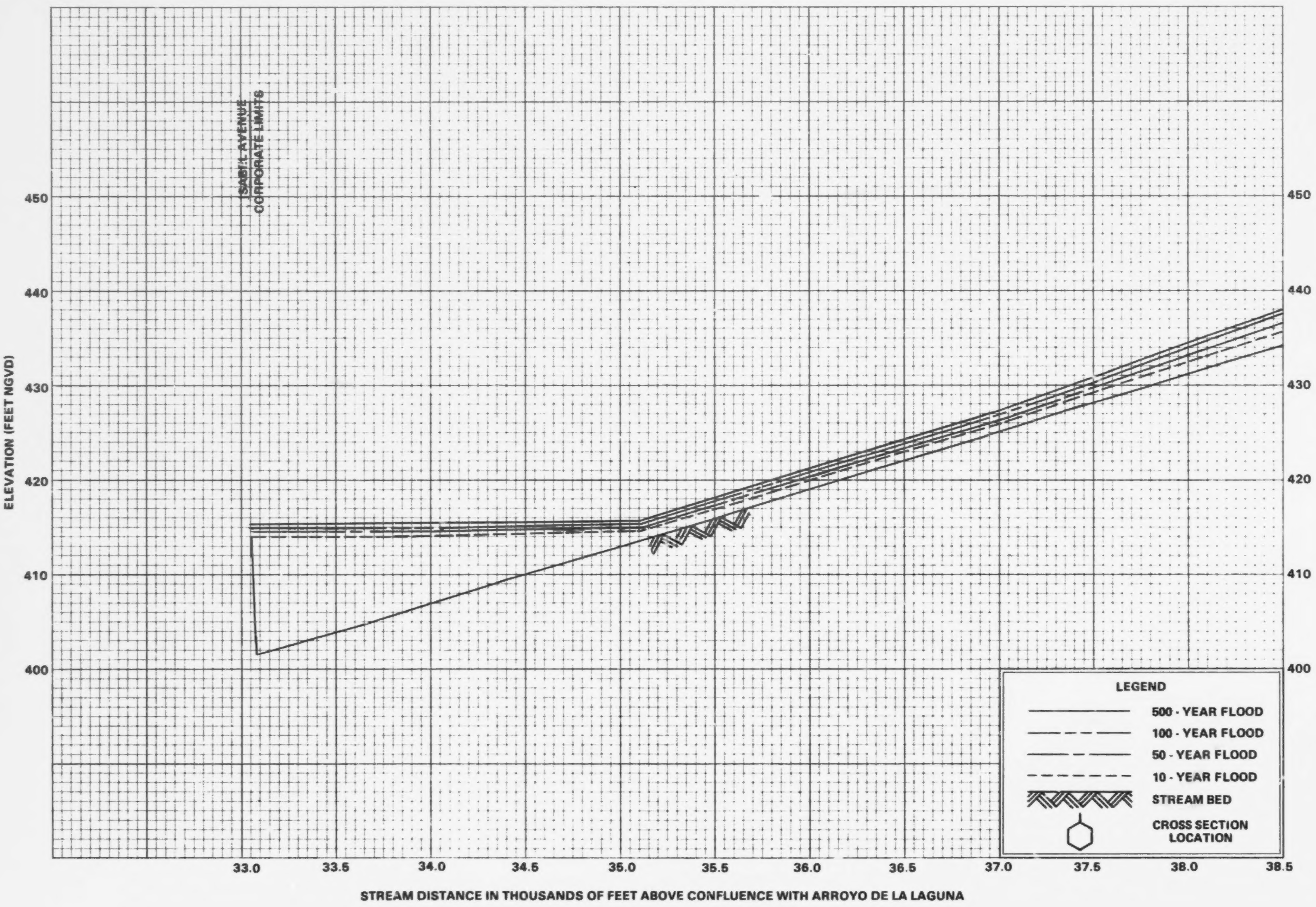
ARROYO LAS POSITAS RELOCATION

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)

22P



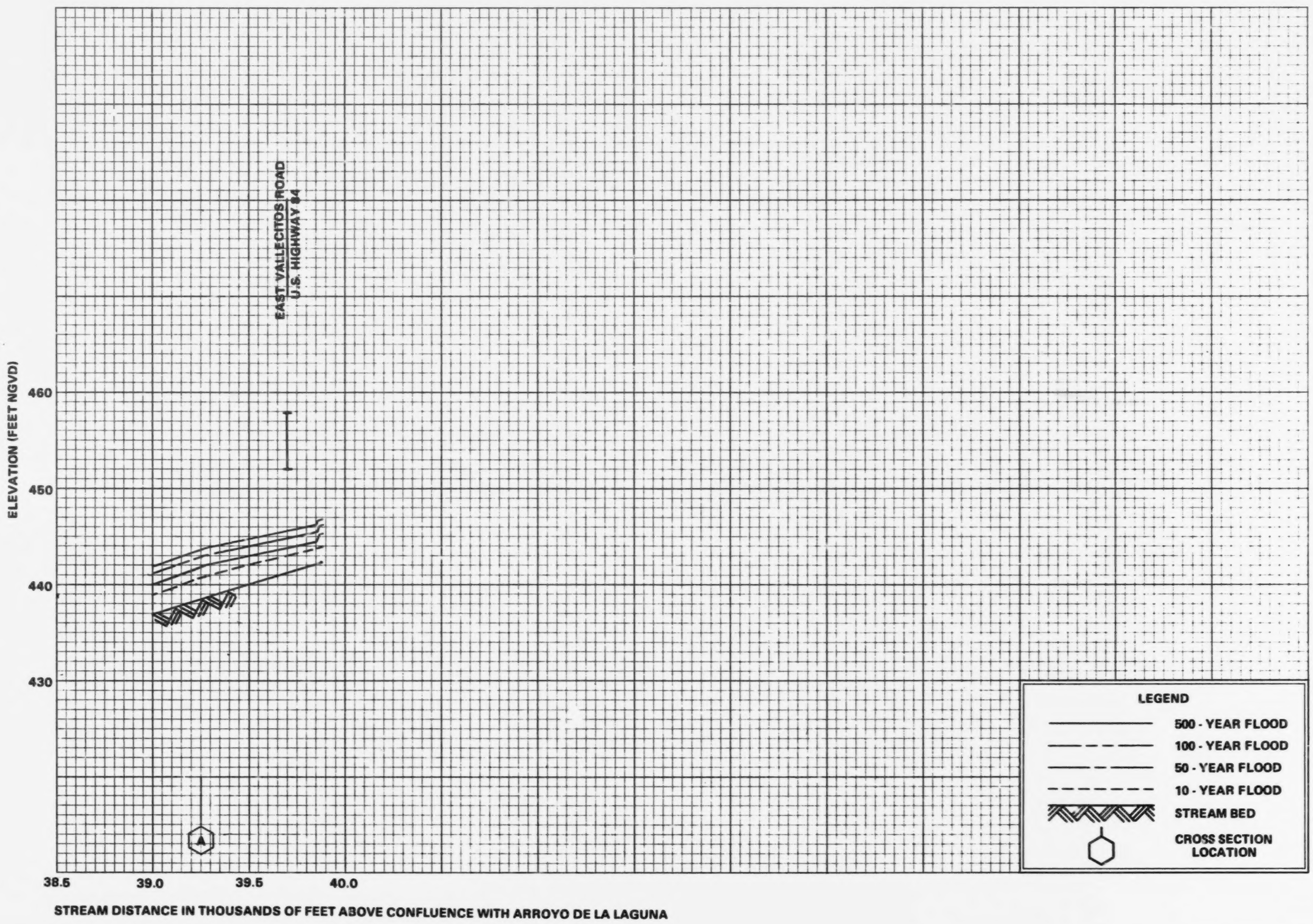
FLOOD PROFILES

ARROYO DEL VALLE

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

23P



FLOOD PROFILES

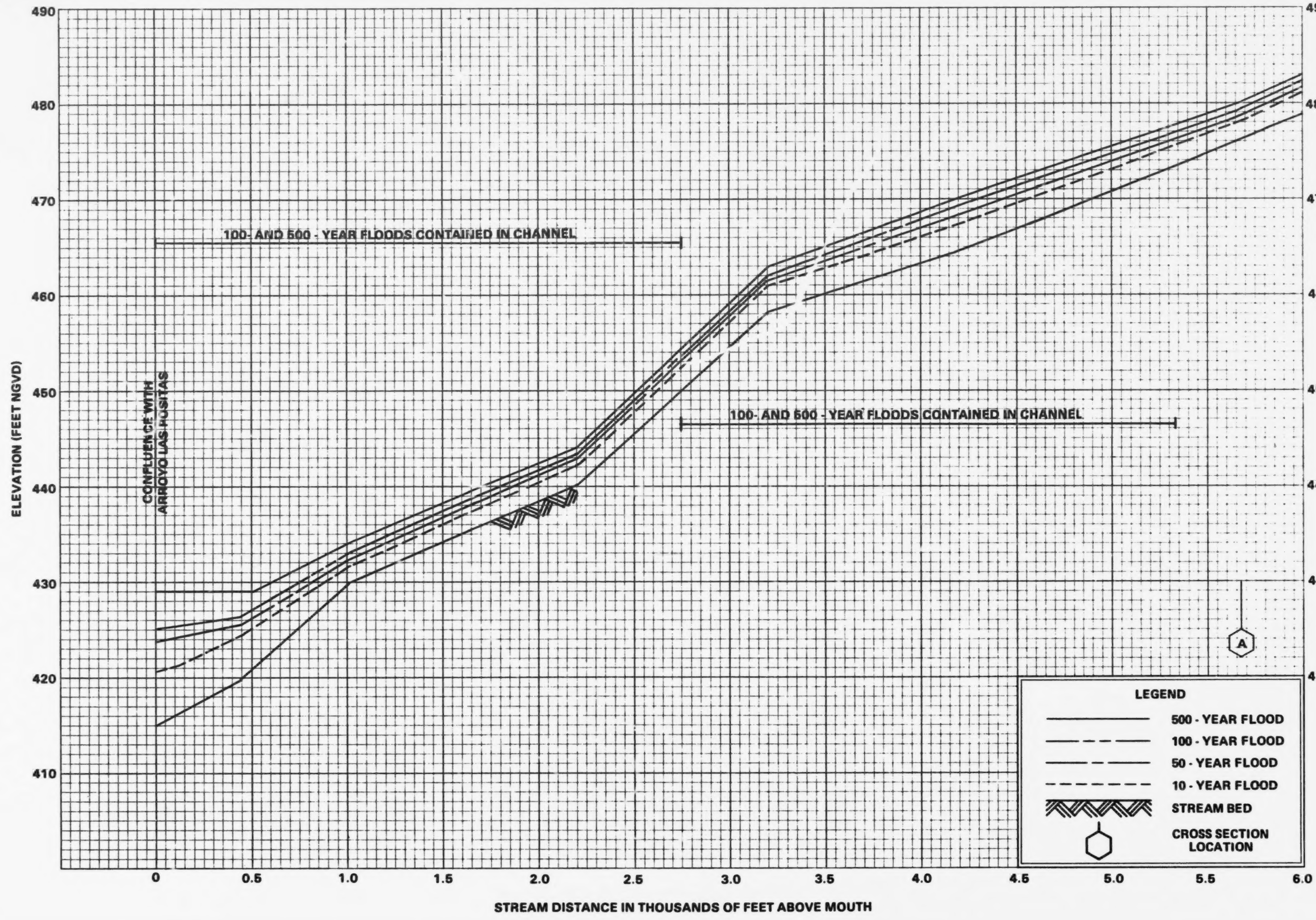
ARROYO DEL VALLE

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

24P

55



FLOOD PROFILES

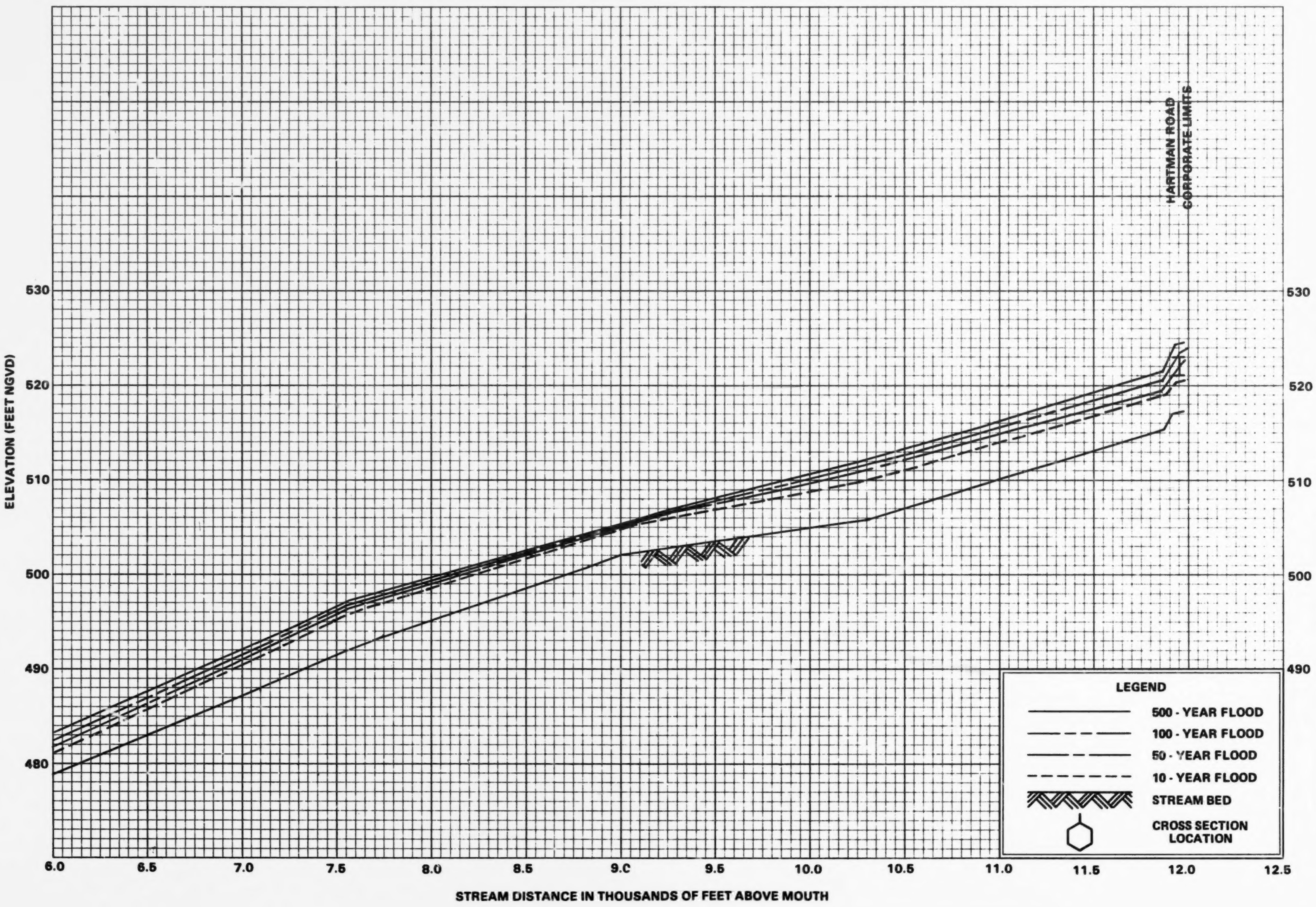
CAYETANO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA

(ALAMEDA CO.)

25P



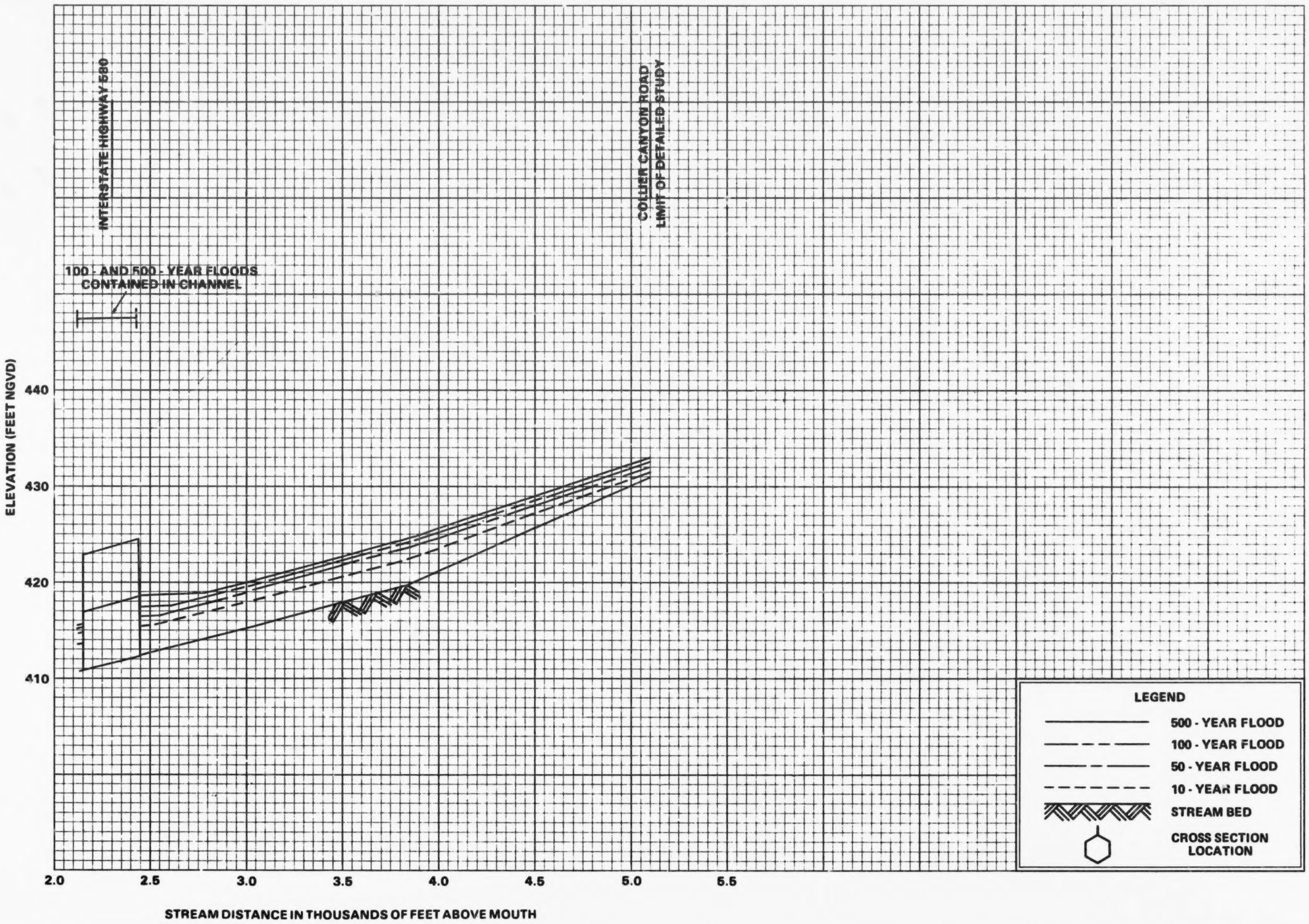
FLOOD PROFILES

CAYETANO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

26P



FLOOD PROFILES

COLLIER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIVERMORE, CA
(ALAMEDA CO.)

27P

58

EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	Elevation (Feet NGVD)	Description of Location
*RM 1	372.475	A California Highway Commission disk No. A 4 1959 in casing at centerline Station Marker "Bo" 190+00.00 on State Highway 50 approximately 0.34 mile east of Croak Road.
*RM 2	382.652	A California Highway Commission disk No. A 5 1959 in casing at centerline Station Marker "Bo" 180+00.00 on State Highway 50 approximately 0.46 mile west of Doolan Road and about 0.53 mile east of Croak Road.
RM 3	373.356	City Monument at west end of Clubhouse Drive (H31).
RM 4	386.328	U.S. Coast and Geodetic Survey bronze disk No. L 832 1947 RESET 1948, 2.9 miles west along the Southern Pacific Railroad from the station at Livermore.
RM 5	383.561	City Monument in intersection of Airway Boulevard and Clubhouse Drive (H23).
RM 6	414.589	U.S. Coast and Geodetic Survey bronze disk No. K 832 1947, 2.0 miles west along the Southern Pacific Railroad from the station at Livermore.
RM 7	397.439	City Monument at intersection of Airway Boulevard and Kitty Hawk Road (H16C).
RM 8	436.945	A standard Alameda County disk in the west end of the concrete headwall at the outfall of the culvert at road mile 0.45 on Collier Canyon Road.
*RM 9	422.020	Along East Vineyard Avenue to Pleasanton, Latitude 37° 30', Longitude 121° 45'. A standard Alameda County disk in a concrete monument.
RM 10	420.032	Approximately 1,200 feet north along Isafel Avenue from its intersection with East Vineyard Avenue. Latitude 37° 30', Longitude 121° 45'. A standard Alameda County disk in a concrete monument.

*Located Outside Corporate Limits

EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	Elevation (Feet NGVD)	Description of Location
RM 11	448.202	Along East Vineyard Avenue to Pleasanton, Latitude 37° 30', Longitude 121° 45'. A standard Alameda County disk in a concrete monument.
*RM 12	456.538	From point on State Highway 21, 1.1 miles southeast of Sunol east and northeast along Livermore Road to point 2.0 miles south of Livermore, in southeast curb of bridge over Arroyo Del Valle, bolt head.
RM 13	473.341	City Monument at intersection of Holmes Street and Mocho Street (A26).
RM 14	457.933	A California Highway Commission disk No. A 27 1959 in casing at centerline Station Marker "F1" 767+50 on U.S. Highway 50 approximately 0.41 mile west of Beck Road Bridge No. 33-153 and approximately 0.20 mile east of Arroyo Las Positas Bridge No. 33-92.
RM 15	533.523	U.S. Coast and Geodetic Survey Bench Mark Disk No. P832, 1.5 miles northeast along the Southern Pacific Railroad from the station at Livermore, in R2E T3S S10, at Trevarno Siding, at the Coast Manufacturing and Supply Company, about 100 feet southeast of the track, at the northwest side of the main gate, at a warehouse loading platform, in the top of the east corner of the concrete platform, 7.5 feet southeast of the building, 1.4 feet west of the east corner of the platform, and about 3.5 feet above the ground.
RM 16	553.126	City Monument on Lucille Street just north of Arroyo Seco crossing (F122).

*Located Outside Corporate Limits

EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	Elevation (Feet NGVD)	Description of Location
RM 17	536.557	U.S. Coast and Geodetic Survey Bench Mark Disk No. N832, 2.3 miles northeast along the Southern Pacific Railroad from the station at Livermore, set vertically in the northwest face of the east concrete abutment of the Western Pacific Railroad Overpass 49.88 over the Southern Pacific Railroad, 38.8 feet northeast of the southwest end of the abutment, 8 feet southeast of the southeast rail, and 6 feet above the ground.
RM 18	515.160	Top of fire hydrant north of intersection of Scenic Avenue and Heather Lane (G9).
RM 19	509.027	City Monument in intersection of Crestmont Avenue and Broadmoor Street (G13).
RM 20	576.541	City Monument on Charlotte Way just north of Arroyo Seco crossing (F2-6).
RM 21	524.196	City Monument in intersection of Crestmont Avenue and Vasco Road (G16).
RM 22	601.029	U.S. Coast and Geodetic Survey iron disk No. Z 737 1944, along Greenville Road, at Western Pacific Railroad Overpass 52.06.
RM 23	640.766	U.S. Coast and Geodetic Survey iron disk No. X 737 1944, 2.8 miles southwest along Southern Pacific Railroad from abandoned station at Altamont, at the overhead crossing of the Western Pacific Railroad (Southern Pacific Bridge 52.15) set vertically in the southeast part of the northwest concrete pier.